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NAHAN FOREST DIVISION, NAHAN (HIMACHAL PRADESH).

Photo - Pankaj Khullar

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VOLUME 122 **NUMBER 1**

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JANUARY, 1996

EDITORIAL

Dear Reader,

The year 1996 sees the *Indian Forester* enter its 122nd year of continuous publication - a feat of which we are justifiably proud. The Editor takes this opportunity to wish all subscribers, contributors and readers a *Very Happy and Prosperous New Year*, and assures that the *Forester* will continue to provide the same quality fare that subscribers have become used to over the last twelve decades, if not better. We extend our sincere thanks to all who have supported our venture over the years gone by, and hope that we will continue to enjoy their goodwill and support in the years to come. Special thanks are due to the editorial and office staff, and the Assistant Manager, without whose hard work, perseverance and sagacity the *Forester* might have folded up years ago. Though our financial position continues to be tight, we look for increased circulation to enable us to keep afloat. The Editor hopes that regular subscribers will not mind the slight increase in subscription and advertising rates, effective from this month, and continue to lend us their valuable support, as hitherto.

As we usher in the new year, we also need to take a look at the year gone by. The last year has seen several positive developments in the area of forestry research. The World Bank funded Forestry Research Education and Extension (FREE) Project has enabled the Indian Council of Forestry Research and Education (ICFRE) and the State Forest Departments (SFDs) to procure sophisticated equipment, and services of renowned scientists, from India and abroad, to boost research in areas such as genetics, biopesticides, biofertilisers, nursery management and so on. Perhaps the best part of the Project is that contacts between ICFRE, the SFDs, the Agriculture/Forestry Universities (SAUs) and NGOs have been considerably strengthened. SFDs have renewed interest in laying out Provenance Trials, Seed Stands, Seed Orchards and Demonstration Plots, with the technical and financial support of the ICFRE and its Institutes, and SFDs/SAUs/NGOs are being provided specific research and extension support through Research Grant Fund and the Extension Support Fund of the FREE Project.

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The importance of continuing education and training to researchers and field personnel has received due recognition, and several scientists and field personnel have been sponsored for training abroad, for short and long term training courses, in various areas of forestry research and applications. If the number of requests being received by the FRI for training of field personnel in various aspects of forest management and practices is any indication, the SFDs have finally realised the importance of continuous updating of knowledge and skills, at all levels, a development that is sure to be of immense help to the country in the long run.

We wish the forestry sector all success and hope that researchers and others will continue using the columns of the *Indian Forester* to share with others their problems and successes.

Pankaj Khullar
Hony. Editor

BIOMASS FLUCTUATIONS IN ALPINE PASTURELANDS OF KASHMIR HIMALAYAS

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Introduction

Alpine pastures in India occupy 1.52% of the total land area in the country, which is mainly concentrated in the four Himalayan States of Arunachal Pradesh, Sikkim, U.P., H.P. and J&K. Against 25.88% area under alpine pastures in above States, the total area under alpine pastures in J&K alone constitutes 59.33% of the total geographical area. On these alpine pastures is dependent the economy of 2.00 lakh Gujjars, 34,899 transhumance Bakkerwals, 18,039 Gaddies, 3,511 nomadic Changpas and 54,017 semi-nomadic Purigapas and other semi-sedentary grazing communities of the State.

In past forty years State of Jammu and Kashmir has witnessed exponential increase in the population of livestock. This has resulted into crowding of all alpine pastures with consequential reduction in their grazing capacity. It is estimated that against the carrying capacity of 2 HSU/ha the grazing intensity far exceeds 6 to 8 HSU/ha. Hence the degradation and depletion of pasturelands is obvious and this necessitates the study of alpine ecosystem for better understanding and scientific management for sustained production.

Present study is therefore an attempt to analyse the structural and functional aspects of alpine meadows locally known as Margs, located along one of the oscillations corridors of transhumance herdsman.

Materials and Methods

The study site was located along one of the major oscillation routes of transhumance herdsmen, in Pirpanjal mountain range of Kashmir Himalaya at an average altitude of 3400 m a.s.l. The study sites are situated in the lap of famous Dhakyar Peak (3650 m) surrounded by several Margs, in Rajouri District, popularly known as Rupri Marg, about 300 km from the city of Jammu between longitude 74° 35' and 74°40' East and latitude 33°25' to 33° 35' North. For present study, three sites were selected at different elevations viz., Sewari (3200 m), Badjari (3400 m) and Bela (3600 m). Area remains under snow for about nine months and is exposed to pasturage for only three summer months i.e. July, August and September. These Margs get natural irrigation from the melting glaciers and several lakes located in the area.

Various sampling sizes have been used for biomass assessment studies by different workers depending on nature and composition of plant community (Gupta, 1979; Kaul, 1981). In the present study a quadrat size of 10 x 10 cm was selected. The plant biomass changes were estimated by harvest methods (Misra, 1968) by recording frequent readings at an interval of ten days initially and seven days afterwards upto month of August and again at ten days interval till the first snowfall in the area. For estimation of below ground biomass, soil monolith of 10 x 10 x 10 cm was excavated and washed with water. Plants with clear roots were taken out and packed in polythene bags. These were brought to laboratory for further analysis. Plant material was then separated into above-ground live, above-ground dead and underground parts. Litter was collected manually with the help of forceps and separately from each quadrat. In the present study species-wise biomass analysis was not carried out as it was concerned mainly with the total herbage production vis-a-vis livestock consumption in the pasture.

All plant parts were oven dried at 80^0C for a period of 24 hours. Dry weight of each part was recorded to determine the productivity of the biomass.

Results and Discussion

During the course of study the mean above-ground live biomass ranged from 56.13 gm/m^{-2} to 146.10 gm/m^{-2} in grazed sites and it varied from 52.00 gm/m^{-2} to 170.83 gm/m^{-2} in fenced sites. The difference in production of peak biomass at different sites may be due to grazing effect, because in undisturbed area the production goes on increasing gradually. In grazed sites whatever is produced is consumed daily by nomadic herds/flocks. At individual sites (Sewari, Badjari, Bela) values were fluctuating because of grazing behaviour of animals and the daily routes they follow for grazing. The mean about biomass of 101.55 gm/m^{-2} compares well within the world average range of shoot production. Coupland (1979) reported mean green (live) shoot biomass ranging from 50 to 827 gm/m^{-2}. Lowest values were typical of semi-arid and temperate and alpine pastures.

The standing dead biomass fluctuated throughout the year recording maximum values at certain dates of observation. The mean standing dead biomass of study site ranged from 51.20 gm/m^{-2} to 137.23 gm/m ^{2} in grazed sites and 78.33 gm/m^{-2} to 122.24 gm/m^{-2} in fenced sites. This value is also within the world average range of dead shoot biomass which ranges from 10 gm/m^{-2} to 506 gm/m^{-2} (Coupland, 1979). Individual sites recorded no set pattern or trend, an observation also noticed in the analysis of data of world grassland sites. The mean values indicate that accumulation of standing dead biomass was more in grazed sites than in fenced sites.

The standing crop of ground litter at all sites remained fluctuating throughout the grazing season showing general trend of decline from snow melting to first snowfall. The mean litter biomass of Rupri Margs in grazed sites ranged from 102.13 gm/m^{-2} to 259.7 gm/m^{-2} and in fenced sites it ranged from 48.33 gm/m^{-2} to 366.66 gm/m^{-2}. In both cases peak values were recorded on first recording just after first snow melt from the meadows and showed a declining trend till snow fall. These values are also within the world average of 70 to 900 gm/m^{-2} (Coupland, 1979). Grazing affects the litter production since cattle (herbivores) remove the portion of green herbage as well as dead parts both of which contribute to litter. During the accumulation of above-ground live biomass, transition of live parts tissue to standing dead also takes place, ultimately leading to litter formation. Transition from living to standing dead tissue can be attributed to the insect action or breakage through mechanical means caused by either biotic interference of environmental factors like

Table 1

Mean above-ground live, Litter standing and maximum under-ground biomass for herbaceous ecosystems in gm^{-2}.
(Modified after Jain & Mishra, 1972; Pandey, 1978; Gupta, 1979 and Koul 1981)

Author	Location	Vegetative Type	Biomass gm^{-2}			
			Green top	Litter	S. Dead	Roots
1	2	3	4	5	6	7
Kelley *et al.* (1969)	Tennessee	*Andropogon* dominated	219.1	181	650	804
	Tennessee	*Festuca* dominated	182.3	114	327	765
Haris (1966)	South Carolina	*Andropogon* dominated	-	258	382	-
	South Carolina	*Festuca* dominated	-	49	109	-
Golley (1965)	South Carolina	*Andropogon* dominated	46.3 to 135.6	135-250	335	-
Golley and Gentry (1966)	South Carolina	Field abandoned 1 year	-	309	11	-
	South Carolina	12 yrs	-	480	189	-
Odum (1960)	South Carolina	Forb dominated	-	300	189	-
Ovington *et al.* (1963)	Minnesota	Prairie	-	279	-	669.5
	Minnesota	Savanah	-	1365	-	1490.1
	Minnesota	Maize field	-	-	-	121.0
Wieger and Evans (1964)	Michigan	Predominated Sevale	-	434	-	1018
	Michigan	Predominated upland	-	202	-	685
Dahlman and Kucera (1965)	Misssouri	Prairie	-	-	-	1901
Porter (1967)	Florida	*Muhlenberga* dominated	119.4	-	-	-
Varshney (1972)	New Delhi	*Heteropogon* dominated	338.8	-	-	-
Jain (1971)	Sagar	-	187.3 to 195.8	295	331	-
Chowdhary 1972	Varanasi	*Dichanthium* dominated	149.1	93	129	1008
Singh (1973)	Ujjain	*Sehima Chrysopogon*	84.8	-	-	-

Contd...

1	2	3	4	5	6	7
Misra (1973)	Ujjain	*Dichanthium* dominated	159.2	225	164	925
Billore (1973)	Ratlam	*Sehima* dominated	104.1	168	190	873
Singh (1967)	Varanasi		-	-	-	583.8
Jain & Mishra (1972)	Sagar	-	-	-	-	1537.36
Numata (1978)	Lanzhot Czechoslovakia	*Festuca sulcata*	152	-	121.5	1556.00
	Hungary Csevharaszt	*Festuca vaginata*	155.5	-	181.0	863.0
	U.S.S.R. Karachi	*Phleum phleoides*	130.5	-	313.5	2350.0
Koul (1981)	Nilnag (J&K)	Ground vegetation	488.17	58.38	164.03	565.05
Gupta (1979)	Yusmarg (J&K)	Meadow Land Fenced	482.00	353.78	604.00	2418.18
		Grazed	60.52	87.94	142.23	644.89
Present work	Rupri Marg	Alpine Fenced	123.17	163.61	98.43	2175.6
		Grazed	95.05	159.04	96.15	1842.2

wind and rain. Accumulation of standing dead biomass in winter may be attributed to the maturity which decreases the metabolic activities of the plant tissue before the onset of winter. Larger root/shoot ratio indicate an adoption for reducing transpiration surface while increasing the water absorbing surface. The mean root/shoot ratio in grazed sites was recorded as 15.66 as compared to 15.81 in fenced sites.

The mean below ground biomass of Rupri Margs indicated more production in fenced sites than in the grazed sites. In grazed sites values ranged from 1215.24 to 1842.50 mg/m^{-2} and in fenced sites it varied from 1443.3 gm/m^{-2} to 2175.6 gm/m^{-2}. In both cases one peak value was recorded. The difference of biomass production in grazed and fenced sites is indicative of more stress on below ground parts due to grazing. However, as observed in world averages (45 to 4707 gm/m^{-2}) higher values of below ground biomass at study site are in agreement with Coupland's (1979) observation, that higher values are recorded in temperate grasslands than in tropics. This is probably due to part to a slower rate of turnover associated with lower temperatures at high altitudes. Billore (1978) concluded that in heavy grazed sites the energy accumulated was higher in below-ground parts. Lower values in growing season and higher value in the beginning of season i.e., July, may be due to accumulation of food material in winter and translocation of same in the growing season to above-ground parts, Numata (1979) remarked that the absolute values of biomass depend on the latitude, altitude, soil fertility, weather and amount of soil moisture. (Table 1 summarizes the comparative mean above-ground live, standing dead, litter and underground biomass for herbaceous ecosystems of the world.).

Total biomass in grazed sites varied from 1271.37 gm/m^{-2} to 1958.00 gm/m^{-2}. It was recorded in last weak of July 1992. Similarly in fenced sites it varied from 1570.8 gm/m^{-2} to 2302.90 gm/m^{-2}.

In order to improve alpine pasturelands the scientific management of these pastures therefore need to be considered holistically promoting a balanced development of grassland - livestock and the grazing communities.

Acknowledgements

The permission accorded by Government of Jammu & Kashmir to carry out this study under the guidance of Prof. Shashi Kant, Head, Department of Biosciences, University of Jammu is greatly acknowledged.

SUMMARY

In the present paper, biomass fluctuations in a free grazing alpine pastureland of Kashmir Himalayas have been studied. The plant biomass fluctuation showed no definite trend in both grazed and fenced sites. Above-ground (live) biomass attained its peak values 118.23 gm/m^{-2} in grazed sites and 113.65 gm/m^{-2} in fenced sites, in the month of August. Root/Shoot ratio was higher in grazed sites than in fenced sites. The results of studies conducted in alpine meadows of Kashmir Himalayas (Rupri Marg) indicate that the seasonal grazing by the transhumant and nomadic grazing societies significantly affect the structural and functional attributes of alpine pasturelands of the State.

कश्मीर, हिमालय की आल्पाइन चरागाह में जैवपुंज की घटा-बढ़ी

सी०एम० सेठ

सारांश

प्रस्तुत अभिपत्र में कश्मीर के हिमालय प्रदेश में खुली चराई के आल्पाइनी चरागाह में जैवपुंज की घटा-बढ़ी का अध्ययन दिया गया है । चराई किए और बाड़ लगाए स्थलों में जैवपुंज की घटाबढ़ी में कोई स्पष्ट प्रवृति प्रतीत नहीं होती । भूमि से ऊपर के (सजीव) जैवपुंज चराई किए क्षेत्र में शिवर अर्हां 118.23 ग्राम/वर्ग मी० और बाड़ लगाए क्षेत्र में 113.65 ग्राम/वर्ग मी० अगस्त में प्राप्त हुई । जड़/प्ररोह अनुपात बाड़ लगाए क्षेत्र की तुलना में चराई स्थलों में अधिक रहा । कश्मीर हिमालय क्षेत्र (रूपड़ी मर्ग) के आल्पाइनी घास क्षेत्र में किए अध्ययन के परिणाम संकेत देते हैं कि स्थायी और घुमन्तू चराई समुदायों द्वारा की गई मौसमी चराई इस राज्य की चराई भूमियों की संरचना और कार्यगत अंगों पर काफी प्रभाव डालती है ।

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FORESTRY AND SUSTAINABLE DEVELOPMENT

KALYAN CHAKRABARTI*

Introduction

There is an enormous variety of plants and animals on Earth, and the high degree of species richness in tropical forests and coral reefs is a marvel. But even in environments that are relatively species poor, such as the ocean bottom, hundreds of kinds of micro-organisms, plants, and animals flourish. This tremendous prodigality of nature has astonished and delighted humans and is ultimately the source of their sustenance. Yet, in using plants and animals for food and clothing, for building houses and for medicine, humans are endangering this immense richness of species. The current rate of loss of species diversity and the reduction in the genetic variety of crops and wild species could seriously affect human welfare.

Biological Diversity

People alter the biodiversity of the Earth in both direct and indirect ways. The use of renewable resources, for instance, often directly decreases species diversity. This is especially true in extractive industries such as forestry or fisheries, which tend to over exploit useful species and destroy unwanted ones. Agriculture and animal husbandry also destroy or modify the native biota. In addition, people indirectly change biodiversity by burning fossil fuels and biomass for energy, by altering hydrological patterns, by intentionally or accidentally introducing exotic species that reduce interregional biodiversity; and by destroying hedges, forest fringes, and fallow lands that provide habitat. A new and powerful human threat to species diversity is the release of toxic chemicals, such as lead, mercury, fluorocarbons, and chlorinated pesticides, into the atmosphere, soil, rivers, lakes and oceans.

The task of describing, cataloguing, and explaining the diversity of living organism belongs to biologists. But because the number of organisms on the planet is estimated to be 3 to 8 million or possibly higher, and fewer than 1 million of these have been described and catalogued to date, this job is far from complete. The task is so formidable, in fact, that it may never be completed. Nevertheless, it is important to see patterns in the distribution and abundance of species and to test hypotheses about the function of species diversity in ecosystems.

Today, scientists have only a very rudimentary knowledge of biodiversity. In many temperate and arctic areas, where there are comparatively few species, acceptable catalogues of the vascular plants and vertebrate animals do exist. There are also reasonable estimates of invertebrate animals and non-vascular plants, including fungi. Less known in these areas are soil organisms, bacteria and viruses.

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On the other hand, in tropical regions, where there is a high degree of species diversity, the story is very different. There are no detailed lists of the plants and animals of many tropical countries. At best, there are very rough estimates of the sorts of animals, plants and fungi that live in tropical regions. Most tropical insects, soil organisms, bacteria and fungi have yet to be collected and described.

Another serious problem is that scientists do not understand exactly how the diversity of genes, genotypes, species and communities influences ecosystem function. Over the past 100 years, geneticists, taxonomists, evolutionists, and ecologists have accumulated much knowledge about diversity. The information gathered attests to the importance of diversity for the proper functioning of many organisms and ecosystems. However, a comprehensive, rigorous and general theory of biodiversity is lacking. Because the threat to biological diversity is now great, scientists must learn how living systems are influenced by changes in diversity. Given the rapid pace of landscape transformation worldwide, there is some urgency in obtaining this information. Knowledge of biodiversity is also very important for evaluating the impact of global climatic change.

Fossil records show that drastic environmental change has been the major cause of species extinction. Species losses also derive from mutual interaction, such as competition and predation. Also, because the environment is in a constant state of transformation, some species are always being lost. Some changes in the physical environment are cyclical and repeated, while others are less predictable. (However, even cyclical changes are subject to change). In any case, it seems reasonable that genetic diversity provides organisms and ecosystems with the capacity to recuperate after change has occurred. The scientific evidence for this hypothesis is not conclusive, however.

Equilibrium in Nature

An ideal state in which every element is in equilibrium, or "the balance of nature", cannot exist. The weather changes constantly; the diversity of plants and animals fluctuates; mountains erode; and lakes get silted in. Yet this idea of a balance, of an equilibrium in nature, has persisted. Conservation managers, for example, endeavour to reduce disorder and create undisturbed environments. Those scientists who support the notion of a balance of nature maintain that ecosystems, although not in balance now, are moving constantly toward equilibrium. These scientists argue that ecosystems are prevented from attaining balance because of exterior forces, which are called disturbances. Storms, floods, pests, outbreaks, fires, and human-induced changes are all examples of disturbances that are presumed to keep ecosystems from reaching equilibrium.

The matter of conservation of Wildlife resources, specially in the developing and under-developed world seems to have run into serious trouble during the current times. So much so, that the future of conservation itself seems to be under a cloud of doubts at the moment. The pros and cons of this vital issue certainly merits serious consideration after detailed deliberations at the IVth World Congress. Finding out a solution to the new dimensions of the problems that are emerging in the field of conservation of wildlife resources, specially in the tropical regions of the globe, appears to register as crucial if not a critical step to be taken up for the Biodiversity and Gene Pool reserve protection, intricately linked up with, now almost certain, global warming with the dreaded results that are likely to follow.

There is no shadow of any doubt that preservation of the available wildlife resources and their natural habitat has become imperative for the human species for their future survival, even if other considerations may be waived to accommodate the spiralling demand on such resources by an ever-rising population of the *Homo sapians*. Lifeline on this earth of ours has been designed in an intricately woven cobweb of various life forms, both static and dynamic and volumes have been spoken and written by numerous people about the perilous fallout of breaking this natural cobweb for the sake of immediate gain or about the ecological results of extinction of species that usually surface at a much later date, when restoration, even by advanced modern science, has been rendered impossible. Thus the ecological loss and the loss of the species (which is only a part) is permanent and man has to seek alternatives, only with the result of obtaining partial recuperation.

Resource Crunch

With gradual depletion of our global resources over the last century in particular, it has been clearly realised that we have been left with very little room for further manoeuvering in our attempt to make more compromises between the demands of interest of conservation on one hand and utilisation of such resources for various human interests on the other. Unfortunately, these two aspects are directly opposed and naturally immediate human interest has almost always had the last say. Besides, the extremely foolish and dangerous human ego of winning over or improving nature, propelled most likely by stupendous scientific achievements during the last quarter of a century, which had admittedly been mind-boggling, has caused us to commit mistakes, often in the garb of unfounded scientific reasoning and also in the false plea of guarding human interest for the so-called "Development". Obviously in doing so the all important quality of life and the cobweb of lifeline on the earth has been simply overlooked. This has naturally resulted in living a poor quality of life, though we might have achieved the tantalising and debatable easy and comfortable lifestyle in the name of "Development" in civilisation.

However, due to the global natural resource crunch, it has become crystal clear that we have no option but to conserve whatever Biodiversity we are left with at present, mostly in the form of wildlife resources. The main aim of this conservation is to ensure perpetual propagation of these resources and may also include sustainable utilisation, as may be found possible. This will certainly call for *in-situ* conservation and ensuring the natural process of evolution to continue without any hinderance. Because it is this process that ensures the viability and the capability of any species to adjust with natural ecological chain of events and to evolve new species.

Till uncontrolled biotic interference tilted the balance immeasurably in many areas, the ecological processes continued and with various natural succession process, species had been evolved to replace those which had gone extinct during the past. But with the biotic pressure mounting, this natural process got destabilised and the process of evolution came to a sudden halt.

This aspect along with the loss of biodiversity is causing serious anxiety about the future sustainability of mankind. Naturally, the continuance of the evolutionary process is equally important to that of preservation of the biodiversity itself for the reasons stated above.

Besides the biodiversity of any area, it also holds the key to sustain the natural land productivity of the entire region. Through the natural process of decaying or recycling the biomass produced in any area forms the humus in the forest floor and adds to the top soil thus maintaining the productivity. With the drainage system this rich top soil is carried away and deposited in the surrounding areas which provides the natural productivity of the land to sustain agriculture. Naturally, loss of biodiversity will not only impoverish the gene pool resources, but will also adversely effect the natural productivity, the result of which will simply be dreadful.

Sustainable Utilisation

Since utilisation of natural renewable resources is often linked with sustenance of man, strong arguments are raised that utilisation of such resources should be allowed for the "people in and around" the protected areas, where the conservation of biodiversity is contemplated. The argument is built up around past history of conservation in and utilisation going side by side. But with the unprecedented pressure of human population on such resources, it is just not possible or practical to achieve the objective of the conservation of biodiversity, as explained earlier, if utilisation of the resources are to be allowed from the protected areas. The unavoidable and sure fallout of such permission is overuse due to the rising demand on such resources, which probably far outstrips the sustainable limits of production - thus compounding the problem of digration of the habitat or impoverishment of natural ecosystems, which ultimately adversely effects the natural productivity also in a chain reaction. The process thus becomes counter-productive.

In India we have only 0.97% of the country's land area under National Parks, which corresponds to a mere 4.90% of the forest area of the country. While we should have 33% of the total land area of the country under forest cover for ecological reasons, we actually have only 21% or so approximately now under forest cover. Even out of this inadequate forest area we have a large chunk of degraded forest area. And worse still is the fact that even now there is tremendous pressure for diversion of more forest areas for non-forest purposes, which has prompted Govt. of India to enact the Forest Conservation Act.

Project Tiger initiated in 1973 had taken up a plan to adopt "Total ecosystem preservation" in the "Core areas". This naturally involved complete elimination of biotic interference from the core. This objective was meticulously followed in many areas and the results, even in a short span of time of about 10 years, had been really spectacular. The biomass production rose, the sub soil water regime improved and this was responded by a simultaneous rise in population of virtually all wild animal species. In many areas the range degradation that had earlier been caused to such areas, had largely been recovered, which is a standing example of the effect of eliminating human use of the renewable resources from these protected areas.

The people living in and around the protected areas are all extremely poor and mostly belong to various tribal communities who had all along been living almost entirely on the forest and the renewable resources obtained there. These people had been "Ecosystems people" and their living was more or less compatible to the ecological processes underway. But the situation at present is no longer so simple. Firstly, the population of such direct users of the usufructs are also being siphoned out by urban users through indirect linkage, which often remains unnoticed. But the combined effect is devastating on the natural ecosystems.

Thus it will be apparent that if use of renewable resources from the protected areas has to be allowed, the intended aim of recuperation of the range degradation can never be achieved. And only a very small percentage of such area has so far been covered by the protected area net work, as pointed out earlier. This is the basic reason when commercial extraction of any forest produce from the protected area has been stopped under the amended Wildlife (Protection) Act.

But the resultant problems faced by the people have not been overlooked. Already the problem of closure of use of some of the National Park areas during the past has been capitalised by various interested groups. The simmering discontent of the people living in the vicinity has been seized by both hands by thoughtless people for their shortsighted gain and in many protected areas defiance of law and even open confrontation with the wildlife authorities has become common. If this situation is allowed to drift further, conservation of biodiversity may remain only in paper.

Nature Conservation

So much popular interest could persist in a concept so difficult of precise definition. As elements of the natural environment come into the service of man, they are called resources. The diversity of these resources and the rapidity of their consumption have varied with changes in the technology of production. New uses of traditional raw materials and the development of new raw materials alter the proportion in which resources are used in combination. The esteem in which a resource is held varies according to the demand for it, even from place to place at a given time. Historically the United States has thought of conservation as concerned with shortage of resources. Over a period of almost two centuries, writers in the field of economics have been concerned with the problems involving depletion, the disappearance or the wise use of human resources. The tendency to view the conservation problem as essentially one of managing resources in such ways as to produce a maximum of satisfaction of human wants has frequently been very strong. Resources become valuable only to the extent that they are wanted by man; the entire conservation effort, therefore, rests on a projection of patterns of human wants into the future. To an economist 'conservation' involves the act of managing resources in such a way that maximum volume of human wants will be satisfied! The economist would surely identify this act as arising out of a concern for both present and future wants. The practice of conservation is essentially an engineering problem, involving the manipulation of physical entities in ways that permits the predetermined goals. Selection of these goals, however, is not a matter of engineering, but of evaluating the wants and needs of a society. To a forester, "conservation" involves the acts of managing forestry resources in such a way that the greatest good of greatest number of humanity benefits out of it - present and future. An economist will be concerned in conservation with finding the most economical ways of attaining social goals which have been established to resolve the means-resources problems. "Conservation" came to mean the planned use of functioning natural systems in nineteenth century in England. In forestry the word was introduced into Britain from the Indian Forest Service where "conservation" was the guardian of a resource that needed a long view and a knowledge of the ecology of the system.

The term "conservation" thus embraces measures to protect and to enhance the productivity of the biosphere and not simply "preservation". It is really a dynamic process to effectively safeguard the living resources of the biosphere and their habitats and engender their optimum development bringing greatest good to greatest numbers. Development without destruction is perhaps the synthesis of the purport of optimum development.

Historically, conservation may be reckoned as a recent concern of the past 100 to 150 years but is has grown steadily in strength and popular support during recent decades, notably during 1970s. In March, 1980 the conservation movement of the 1970s may be said to have reached a new peak with the launching of the "World Conservation Strategy" prepared by I.U.C.N. in cooperation with U.N.E.P. and World Wildlife Fund (W.W.F.). As per description of Sir Peter Scott (1980) :

> "It was the first time that Government, non-Governmental organisations and experts throughout the world had been involved in preparing a global conservation document; it was the first time that it had been clearly shown how conservation of natural diversity can contribute to the development objectives of government, industry, commerce, organised labour and the professions; and it was the first time that development had been suggested as a major means of achieving conservation instead of being viewed as an obstruction to it".

This "World Conservation Strategy" takes into consideration the human impacts and the perils that may threaten the future of the world's life-support systems. It clearly defines three global objectives of living resource conservation :

- to maintain essential ecological process and life support systems,
- to preserve genetic diversity,
- to ensure the sustainable utilisation of species and ecosystems.

The safeguarding of soil, the enhancement of biological productivity by irrigation and drainage and the improvement of plant diversity and domestic livestock by suitable breeding programmes are all elements in this wider conservation activity.

Conservation of Tropical Forests

Tropical forests yield an extraordinary array of products essential to trade, nutrition and health. Besides producing wood, the forests also provide other raw materials such as essential oil, gums, latexes, resins, tannins, waxes and dyes, etc. Many food plants now taken for granted, including vegetables, fruits, nuts, edible oils species etc., are derived from tropical forests. More than 50% of the modern medicines come from natural world, and a large part of these from tropical plants only. Despite the many potential uses of tropical plants, less than one per cent have been chemically screened for useful medicinal properties. The scale of enormous possibility is emphasised by the fact that no fewer than 1400 tropical forest species are thought to have anti-cancer properties. The food supply of the entire world depends on the ability to breed desirable traits, such as disease resistance, into commercial crops. The use of genetic resources in agriculture has brought about remarkable results.

Between 1930 and 1975, for example, yield per hectare of wheat in United States rose by 115 per cent; of rice by 117 per cent; of maize by 320 per cent; of sugarcane by 141 per cent; and of cotton by 88 per cent. About half the increase can be credited to genetic improvement and breeding technology.

An example of a vulnerable tropical tree species with potentially valuable commercial properties is *Eucalyptus deglupta*, native to parts of Philippines, Indonesia and Papua New Guinea. It is one of the few species of Eucalypt that grows naturally in the humid tropics. Its rapid growth and excellent wood properties make it an important potential source of industrial fibre in tropical regions. But its natural habitat is in fertile river flats ideal for agriculture and many stands of the tree are being cleared, threatening the chance to evaluate the full range of this species' natural variation for use in selection and breeding programmes. This is only one example. The continued destruction of tropical forests could deprive humanity of hundreds of similar new sources of fibre, food, medicine and other essential products of men. But the tropical forests and woodlands are vitally necessary to the economic and social well-being of rural people in developing tropical countries. Hundreds of millions of people in developing countries already face hardship and starvation because of fuel and food shortages. Properly used and managed, the tropical forests constitute a massive potential source of energy, a powerful tool in the fight to end hunger, a strong basis for generating economic wealth and social development, and a storehouse of genetic resources to meet future needs. The tropical forests cover more than 4000 million hectares, or one-third of the earth's land surface. Of the total forest area, about 42 per cent is found in the developed countries (almost all temperate) and 58 per cent in the developing countries (mostly tropical)).

Tropical forests can be of two types: closed forest where the trees and undergrowth combine to cover the ground, as in the closed humid forest found in high rainfall regions of the Amazon Basin and the islands of Southeast Asia; and the second category of tropical forests includes open formations with continuous grass cover, such as the open Savannah woodland found mainly in Africa. Over and above there are other types of forest, including bamboos and mangrove forest. Mangroves are the key elements in marine food chains, which thrive in coastal areas and can be important sources of wood for fuel, building materials and other kinds of human uses. Mangroves also act as shelter belts to arrest the mighty sea waves and in building soil conservation and control floods.

Forests provide energy (half the world's population depends on fuelwood), industrial wood products (20 per cent of which come from developing countries), food, fodder, pharmaceutical products, and other nonwood products such as fibres, rubber, gums and resins. Forests are also a priceless ecological resource, protecting land and water resources, controlling floods, checking wind erosion, storing and cycling nutrients and providing habitats for wildlife denizens. Finally, they constitute a rich stock of valuable genetic resources, a common heritage of mankind.

Ecodevelopment

Government of India has therefore, decided to launch a special scheme called ecodevelopment plan to counter this dangerous trend. Through this scheme socio-economic development of these affected people and to bring down their level of dependence on forests is envisaged. In this scheme amelioration of the living condition of such people with health care, education, etc. has been planned. Poverty and lack of education which are the biggest enemies of conservation are thus sought to be tackled through this plan, besides tackling the problem of a confrontational attitude of the people arising mainly out of the ban on utilisation of the natural resources at their doorsteps, which had been theirs all the time. As expressed earlier various interested groups with all motives, may like to drive economic or political objectives, often fan the disgruntlement of the effected people and incite them to go up in arms against the enforcing authorities, in this case the wildlife managers.

A small example may clarify the matter. In India the demand of fuelwood as estimated roughly is around 350 million cubic metres. But today what is being produced and a substantial part of it may not be silviculturally approved, is only about 45 to 50 million m^3. Naturally the gap is causing immense hardship to the poor rural people as this is the basic need of their living. Obviously when any protected area is closed to human utilisation, the people in and around such area have genuine reasons to resent, unless proper alternative arrangements are made for their basic needs. Mere awareness and environmental education is certainly not enough to keep the affected people on the side of the wildlife manager. Though he may understand that any further depletion of the renewable stock may shorten the viability of his future generations, yet he is only too likely to deplete it all the same, for the sake of sheer immediate survival.

Often ready arguments like, "we are collecting only dry fallen wood which is of no use, for burning" may confront the field wildlife managers or enforcement authorities. Naturally such a person who is extremely poor and has no buying power may not bother about recycling of the dead and dry wood and the (natural) process of maintenance of the natural productivity. Besides fuelwood there are host of other forest produce which is utilised by the people that includes medicinal plants also.

And this is not all. With strict protection offered to wildlife the status of virtually all animal species made improvement which rendered intrusion into cropland and crop raiding by herbivores a constant headache. Along with cattle lifting by large Cats such socio-economic conflicts are bound to raise consternation and apathy against conservation in general. The main problem is just one - the demand has already far outstripped the production, which is impossible to solve unless the demand can be adjusted - by whatever way it may be feasible - by reduction of the per capita use or by finding some alternatives or reducing the actual number of users. The best would probably be to combine all probabilities together, which could produce the fastest and the best result.

Elimination of poverty and educating the masses is every nation's objective in their national planning. But precious little seems to have been achieved, particularly by the developing countries. Enormous efforts and global coordination at political level may only bring about the desired result. But the impact of poverty on the process of the degradation of the ecosystems should be clearly established, so that minimum standard of living conditions may be ensured wherever required, through international cooperation and help.

There should be no doubt about the fact that ignorance about ecological understanding is one of the chief reasons of degradation. There is just no alternative to ensure such knowledge for all. Of course, it may be clearly understood that such education or knowledge may achieve results only upto a certain level after which the level of poverty may have overpowering influence.

The task of retrieving the ecological setback appears to be something extremely hard, specially because of the unavoidable dependence of man on the natural renewable resources for his survival, and how the very sustainability of such resource seems to be seriously doubtful. We must remember, over use and abuse of the natural resources has caused this grim situation and we must not leave the trace of the same cancer in the planning for survival. The protected area net work must be put out of bound for human use for achieving the objectives, that we have set for ourselves.

Sustainable Development

A contemporary phrase 'Sustainable development' has been coined with perhaps a sinister objective to narrow down the baneful effects of so-called development. I strongly feel that there is hardly any developmental activity which fails to cause any misuse or overuse of natural resources. The phrase sustainable utilisation is again a colourful use to cloud the reality of over utilisation of earth's limited carrying capacity by the Super predator, man. As such the term "development" connotes a self-defeating process to human survival, it runs counter to the concept of conservation in its true sense and will continue to be so till the man shakes off his predatory habit to view all the natural products belonging to himself and till the nurtures the misgiving of owning exclusive right of consumerism to satisfy his eternal greed and lust at the cost of all other species and ecosystems. Development without human face is tantamount to destruction.

Conclusion

In a nutshell, four facets of conservation concern people today: resources, pollution, aesthetic heritage and nature. Of these the one that receives the most attention in the press and in the academic world is the supply of natural resources of food, fibre, energy and minerals. Because resources are valued in economic ways, resource conservation, is very properly, the preserve of social scientists and particularly of economists.

It is thus reiterated that conservation of natural resources is not the responsibility of a few specialists, government officials or enthusiasts but every individual, company or organisation must take due share in this gigantic task. What is needed is an enthusiasm and an understanding of the basic tenets of resource and the measures necessary to save from wasteful destruction of our heritage. Conservation education cannot thus be narrowly graded and assigned to a particular age group and people of all walks of life should be well informed of the same and take active role for a common benefit of mankind.

SUMMARY

The paper describes the importance of *in-situ* conservation of biodiversity to ensure the processes of evolution to continue without any hindrance for the overall development of man and to build a holistic and optimum relationship between man and nature. The principal reasons for ecological degradation are poverty and ignorance about the understanding the ecosystem. Thus, people from all walks of life are to be intricately involved in conservation education for the common benefit of mankind.

वानिकी और बना रह सकने वाला विकास

कल्याण चक्रबर्ती

सारांश

इस अभिपत्र में मानव का समग्र विकास बिना किसी बाधा के चलते रहने के लिए उद्विकास की प्रक्रियाएँ सुनिश्चित करने तथा मानव और प्रकृति में पावन और इष्टतम संबन्ध बनाने में जैवविविधता को उसी स्थान पर संरक्षित करने के महत्व का वर्णन किया गया है । पारिस्थिकीय ह्रास के प्रधान कारण गरीबी और परिस्थितिसंहति की समझ का अज्ञान हैं । इसलिए जीवन के सभी क्षेत्रों के लोगों को मावन जाति के समान लाभ के लिए संरक्षण शिक्षा में अविच्छेद्य रूप से सम्मिलित कर लेना आवश्य है ।

Snippets SUSTAINABLE DEVELOPMENT

Georgia-Pacific has developed corporate principles in the areas of safety and environmental concerns. These are quoted from the company's 1994 Environmental and Safety Report. *"Sustainable development, broadly defined, is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. Georgia-Pacific will manage its forests for sustained yield by ensuring that projected growth balances timber harvests on a long-term basis. The company will practice a land stewardship ethic which integrates the growing, nurturing and harvesting of trees for useful products with the conservation of soil, air and water quality, and wildlife and fish habitat."* Contact: Environmental and Safety Information, Corporate Communications Dept., Georgia-Pacific Corp., 133 Peachtree Street, NE, Atlanta, GA 30303.

- Source: *Forest Products Journal, Dec., 1995.*

PROVENANCE TRIAL OF *PINUS CARIBAEA* IN KORAPUT, ORISSA (INDIA)

D. SWAIN* AND T. PATNAIK**

Introduction

Introduction of Tropical pine in Orissa dates back to 1930 when *Pinus kesiya* was planted at Dhudurchampa (Simlipal) by the ex-ruler of Mayurbhanj State. Subsequently plantation of different species of pine gained momentum in the state with one of the important objectives of reforesting the denuded hill slopes, due to shifting cultivation, particularly in the higher altitude pockets like Koraput, Maliput, Kalinga, Daringbadi etc. Out of a few species tried *Pinus caribaea* has been found to be one of the promising species in Orissa (Das, 1971, 1982). In view of the scope for extensive plantation of a few such species, it was recommended in the Seminar-cum-workshop on tropical pine held at Koraput from 11th to 13th November 1982 that provenance trials should be taken up procuring seeds of different origin in order to ascertain the suitable provenance for a particular locality.

In the following paper, results on growth performance and survivability are presented from a provenance trial at Koraput Research Station, Orissa with 20 provenances of *Pinus caribaea* at the age of ten years.

Materials and Methods

Plant Material : The available environmental data of 20 *Pinus caribaea* provenances collected during 1983 are presented in Table 1. The material is part of an international provenance trial organised by the Commonwealth Forestry Institute, University of Oxford and has been supplied by the Forest Research Institute, Dehra Dun, India.

Nursery technique : Nursey beds of size 3m x 1m were dug to a depth of about 30 cm during September-October. Partial burning was allowed on the beds following which the soil was exposed to sun for about one month. Then the nursery beds were prepared with top 10 cm thick layer of fine granular sand having underlying chips. To avoid fungal disease like damping-off each bed was treated with 80 g of a copper fungicide (Blitox) by mixing it with the top sand layer prior to seed sowing as well as the seeds were coated with a thin layer of the chemical. Line sowing (2 cm x 2 cm) of seeds was followed and the seeds were covered with a layer of coarse sand. To promote germination mulching was provided with straw and regulated watering was carried out once or twice a day.

Transplanting : The seedlings generally attain 6 cm to 8 cm height in about 30 to 40 days when they are ready for transplanting into polypots filled with mixture of sand, soil and Farm yard manure (2:1:1). Each seedling was inoculated with mycorrhiza

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from established stands of *Pinus caribaea*. The potted seedlings were maintained in the nursery under shade and regulated watering was done upto end of June.

Planting procedure : Pits of size 45cm x 45cm x 45cm were dug during March-April at a spacing of 3 m x 3 m. Planting was carried out at the onset of monsoon (June-July) when the seedlings were 30cm high. Before planting the pits were refilled with top soil mixed with BHC-10% (15 g/plant) to avoid termite attack. Manuring was done with 50 g of superphosphate which was applied in two splits (July-August).

Post Planting operation : In the first year 3 weedings, in the second year two weedings and in the third year one weeding followed by soil working were carried out.

Information on the experimental site : The Provenance trial was carried out inside Koraput Research Station. Though the experimental site was coming under Moist Peninsular Valley Sal sub-type, it was subjected to repeated shifting cultivation as a consequence of which the site became degraded.

Environmental Data of Location :

Latitude	- 19° 55′ N
Longitude	- 42° 35′ E
Altitude	- 850m above m.s.l.
Mean Annual Rainfall	- 1500mm
Average Max. temp.	- 36°C
Average Min. temp.	- 5°C
Humidity	- 60% to 90%

Soil-Red-Laterite with outcrop of rocks.

Design : The experiment was conducted with a randomised block design having 5 replications. Each plot had 4 x 4 plants at a spacing of 3m x 3m from plant to plant and plot to plot. The spacing between the blocks was kept at 3.5 m.

Parameters studied : Following completion of germination, the percentage values were calculated for each provenance. Height and survival percentage were recorded annually during December 1983 onwards. Similarly the diameter at breast height (1.37m) was recorded annually during December from 1984 onwards. Based on these data, Analysis of variance (ANOVA) is made to find if there is any significant difference on such parameters.

Results

Seed germination (Table 1) : Germination percentage varies from 25 (T_{13} i.e. var-*hondurensis* Prov.- Dulee Nombra culmi olancha Honduras) to 81 (T_9 i.e. Prov.-culmi, Honduras).

Survivability (Tables 2 and 3) : After ten years, the survival percentage varies from 60 (T_{20} i.e. var-*caribaea* Prov-Cuba) to 97 (T_9 i.e. var-*hondurensis* Prov.-culmi, Honduras). It is found that after planting during 1983, the mortality rate increased more rapidly upto 1985 in case of many of the provenances following which the plants showed a trend of resistance with less casualties. Analysis of variance, in respect of survival percentage, shows that there is significant difference between the treatments (Provenances) as well as replications.

Height growth (Table 2 and 3) : Height growth, after ten years, of the 20 provenances varies from a maximum value of 10.01m (T_4 i.e. var-*hondurensis,* Prov-Santa Clara, Nicaragua) to a minimum value of 6.38m (T_{12} i.e. var-*caribaea*, Prov-Cuba). Height growth development of the

Table 1

Information on different provenances of Pinus caribaea tried at Koraput, Orissa, India.

Variety	Origin (Provenance)	Identity No.	Latitude	Longitude	Altitude (m)	Mean annual rain fall (mm)	Mean annual Temp^{0}C	Germination (%)
hondurensis	Los limones, Honduras	24/75	14^{0}03'N	86^{0}42'W	700	663	22.2	55
-do-	Poptun, Guatemala	12/78	16^{0}21'N	89^{0}25'W	500	1688	22.10	68
-do-	Mountain pine Ridge Belize	85/79	17^{0}0'N	88^{0}55'W	400	1558	23.9	37
-do-	Santa Clara, Nicaragua	45/78	13^{0}41'N	86^{0}13'W	600	1800	23.4	44
-do-	Guanaja, Honduras	61/78	16^{0}28'N	85^{0}54'W	50.1	2300	27	81
-do-	Alamicamba, Nicaragua	6/74	13^{0}34'N	84^{0}18'W	20.30	2900	25	46
-do-	Trojes, Honduras	12/76	14^{0}03'N	85^{0}58'W	680-760	1649	23	55
-do-	Mosquita, Honduras	20/80	15^{0}0'N	84^{0}W	11-170	2860	-	63
-do-	Culmi, Honduras	15/76	15^{0}05'N	85^{0}33'W	420-540	1325	24.4	81
-do-	Araslaya, Honduras	42/78	24^{0}30'N	78^{0}20'W	3	1660	25	31
bahamensis	Andros Island, Bahama	69/7296	22^{0}54'N	82^{0}36'W	10	1792	24.7	64
caribaea	Cuba	9/76	20^{0}30'N	83^{0}20'W	100	1477	24.4	65
hondurensis	Dulee Nombra culmi-olancha, Honduras	-	15^{0}06'N	85^{0}37'W	600	1325	24.3	25
-do-	Labrea-colon, Honduras	-	15^{0}02'N	86^{0}04'W	60-200	-	-	43
-do-	Languis Alto Verpaz Guatemala	-	-	-	-	-	-	43
-do-	Yojea Region, Honduras	-	15^{0}02'N	17^{0}67'W	400-600	-	-	64
bahamensis	Bahama	-	26^{0}45'N	77^{0}67'W	10	-	-	55
hondurensis	State Barba, Honduras	-	-	-	-	-	-	33
-do-	British Honduras	-	-	-	-	-	-	39
caribaea	Cuba	-	-	-	-	-	-	75

Table 2

Average tree height, diameter (d.b.h.) and survival % of different provenances (Treatment) of Pinus caribaea - 1983 (Age - 10 years)

Treatment No.	Replication-I			Replication-II			Replication III			Replication IV			Replication IV		Average of Replications			
	Ht. (m)	Dia. (cm)	Sur (5)	Ht. (m)	Dia. (cm)	Sur (5)	Ht. (m)	Dia. (cm)	Sur (5)	Ht. (m)	Dia. (cm)	Sur (5)	Ht. (m)	Dia. (cm)	Sur (5)	Ht. (m)	Dia. (cm)	Sur (5)
T_1	9.04	18.2	67	9.18	18.2	87.5	8.80	18.2	87.5	9.50	16.1	93.7	10.2	17.1	76	9.34	17.5	82
T_2	9.57	18.6	87.5	8.98	16.7	100	8.73	16.6	93.7	10.27	17.0	100	9.06	16.0	100	9.32	17.1	96
T_3	9.61	18.7	87.5	10.29	18.9	87.5	8.59	16.0	100	9.30	17.7	90	10.02	15.9	75	9.59	17.4	88
T_4	10.40	18.8	100	10.55	19.3	93.7	9.6	18.3	87.5	9.20	17.5	100	10.3	18.4	81	10.01	18.4	92
T_5	8.16	17.1	75	8.67	17.0	100	9.09	17.8	100	8.51	17.4	81	9.13	16.5	75	8.71	17.1	86
T_6	9.15	15.8	80	9.72	19.2	100	9.00	18.8	100	9.79	18.3	87	10.7	18.0	87	9.67	18.0	91
T_7	10.29	17.3	100	10.24	18.6	87.5	9.14	17.8	87.5	9.16	17.4	68.7	10.12	17.8	100	9.79	17.7	88
T_8	6.36	15.9	81	8.3	16.0	50	8.34	16.5	87.5	10.08	18.3	87	10.56	17.2	100	8.72	16.8	81
T_9	9.35	16.3	100	9.57	16.0	100	9.46	17.0	100	10.06	17.7	100	8.80	16.1	87	9.44	16.6	97
T_{10}	9.26	17.1	93	8.98	15.1	81	8.96	15.4	68	9.06	17.1	75	10.5	16.0	100	9.35	16.1	83
T_{11}	7.10	11.5	93	8.21	12.8	87	8.31	13.0	87	7.45	10.8	62	9.4	14.1	56	8.09	12.4	73
T_{12}	5.25	10.7	93	6.17	11.7	100	6.80	11.0	56	6.36	10.5	87	7.32	19.6	68	6.38	10.7	81
T_{13}	9.69	17.8	93	9.39	16.8	100	9.23	17.4	93	9.77	17.6	93	10.62	17.8	87	9.74	17.5	93
T_{14}	10.05	20.4	100	9.8	18.0	100	9.18	18.0	93	8.94	19.3	87	9.3	19.1	62	9.45	18.9	88
T_{15}	9.47	16.4	87	9.62	19.0	93	8.85	18.5	75	9.68	18.0	78	9.92	18.7	87	9.57	18.1	83
T_{16}	8.91	17.0	87	10.33	18.0	87	9.91	18.0	93	9.24	16.8	93	9.56	18.0	75	9.59	17.5	87
T_{17}	9.70	14.9	93	8.09	13.9	56	8.92	18.6	93	8.39	13.9	93	8.78	16.7	75	8.81	14.6	82
T_{18}	9.40	16.8	93	9.70	17.7	100	9.33	18.0	93	9.76	16.8	81	10.6	17.6	100	9.68	17.4	93
T_{19}	9.83	17.4	62	8.40	15.6	94	8.60	19.1	81	8.74	17.4	68	9.3	17.5	68	9.97	17.4	75
T_{20}	7.42	13.1	94	7.07	13.6	56	6.61	11.1	56	8.40	11.3	56	6.77	12.8	37	7.17	11.9	60

Table 3

Results of Analysis of Variance for Pinus caribaea provenances at the age of 10 years

Sources of variation	Degree of freedom	F. Value		
		Height	Diameter	Survival (%)
Relication	4	6.183***	0.076	3.527*
Provenances (Treatments)	19	13.94***	26.071***	2.314**
Residual	76			

* Significant at P 0.05; ** Significant at P 0.01; *** Significant at P 0.001

provenances, since establishment of the trial, shows mean annual increments of about 0.7m to 1.0m. Following analysis of variance, it is found that in respect of height growth there is significant difference among the provenances as well as replications. The least significant difference (critical difference) is obtained to be 0.68. Applying the figure it is found that along with the treatment 19 (Seeds of British Honduras origin, collected from Kalinga Research Station, Orissa). Other 13 treatments i.e. T_1, T_2, T_3, T_4, T_6,T_7, T_9, T_{10}, T_{13}, T_{14}, T_{15}, T_{16} and T_{18}, remain in one group where as other six treatments like T_5, T_8, T_{11}, T_{12}, T_{17} and T_{20} are significantly inferior to T_{19}.

Diameter growth (Table 2 and 3) : The diameter growth, after 10 years, of the 20 provenances varies from a maximum values of 18.9 cm (T_{14}, i.e. var-*hondurensis* Prov-Labrea colon, Honduras) to a minimum value of 10.7 cm (T_{12} i.e. var-*caribaea* Prov-Cuba). In general, the annual increment in diameter varies from 1 cm to 1.9 cm. Following analysis of variance, it is found that there is significant difference in respect of diameter growth, between the provenances only. The least significant difference comes to 2.1. Applying this figure it is found that T_{11}, T_{12}, T_{17} and T_{20} remain in one group and are inferior to T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9, T_{10}, T_{13}, T_{14}, T_{15}, T_{16}, T_{18} and T_{19}.

Discussion

From the results obtained on germination, it is found that there is a wide variation in germination percentage among the provenances but there is no corresponding effect on survival percentage. Regarding growth performance T_4 (var-*hondurensis* Prov.-Santa clara, Nicaragua) shows relatively better height growth and diameter than almost rest of the provenances.

This is in accordance with the report made by Greaves and Kemp (1978). Similarly T_{20} (var-*caribaea* Prov-Cuba) almost shows an inferior performance to other provenances. In general, provenances of the var-*hondurensis* show better growth performance than those of var-*bahamensis* and var-*caribaea* as earlier reported by Das and Stephan (1982). Further, var-*caribaea* and var-*bahamensis* do not show any significant growth difference, a trend which has also been noticed by Greaves (1980).

SUMMARY

Result on seed germination, height growth, diameter growth and survival percentage are presented from a provenance trial (1983) at Koraput Research Station, Orissa with *Pinus caribaea* at the age of 10 years. A total number of 20 provenance i.e. 16 of var-*hondurensis*, 2 of var-*bahamensis* and 2 of var-*caribaea* are taken into account. Following an analysis of the above parameters, it is found that Prov-Santa Clara, Nicaragua of the var-*hondurensis* shows relatively better performance than rest of the provenances where as Prov-Cuba of the var-*caribaea* shows a poor result in comparison to other provenances.

पाइनस *कैरिबिया* के कोरापुट, उड़ीसा में स्थानज परीक्षण

डी०स्वैन व टी० पटनायक

सारांश

कोरापुट अनुसंधान केन्द्र, उड़ीसा में *पाइनस कैरिबिया* को 10 वर्ष की उम्र पर लेकर किए गए स्थानज परीक्षण (1983) में उसके बीज अंकुरण, ऊँचाई वृद्धि, व्यास वृद्धि और अतिजीविता प्रतिशत के परिणाम प्रस्तुत किए गए हैं । कुल मिलाकर २० स्थानजों अर्थात 16 *होंडुरेंसिस* विभेद के, 2 *बहामेंसिस* विभेद के तथा 2 *कैरिबिया* विभेद के, को विचारार्थ लिया गया । उपर्युक्त परिमापों का विश्लेषण करने के बाद यह पाया गया कि अन्य स्थानज भेदों के मुकाबले में होंडुरेंसिस विभेद के सांताक्लारा, निकारागुआ स्थानज की क्रियाशीलता श्रेष्ठतर रही जबकि अन्य सभी स्थानजों की तुलना में *कैरिबिया* विभेद काकूबा स्थानज परिणाम में सबसे घटिया रहा ।

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SUSTAINABLE DEVELOPMENT AND MANAGEMENT OF FORESTS

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Introduction

The area of the world's forests is being greatly reduced by human action. By the mid-twentieth century possibly as much as 50 per cent of the original area had gone (Sommer, 1976; Myers, 1979). In 1980, 2.7 billion ha were under closed forests and 1.3 billion ha were supporting some kind of woody vegetation (Anon., 1982). The rate of annual deforestation is the highest in Asian and Pacific countries (nearly 1.2 per cent) followed by Latin American and Caribbean countries (0.8 per cent) and African countries (0.7 per cent) (Anon., 1993). India is losing forest cover at the rate of 1.3 million ha every year. With such heavy deforestation annually especially in the tropical countries, the impact on climate is clearly visible to all of us. Forests are and will remain, for at least three reasons : first, they are the natural climax vegetation of between 4 billion and 6 billion hectares of land throughout the world (Anon., 1992). Second, they are the optimal land use for the area and third, they (especially tropical forests) supply a wide range of products and services (Myers, 1988).

The Concept of Sustainable Development of Forests

The term 'sustainable development' is the new buzzword in forestry conservation. Sustainable development of all types of forests worldwide has now emerged as priority items on the international policy agenda. Sustainable development of forests is also emerging as a consideration in the international trade of forest products. The idea that economic growth and environmental conservation can and should be compatible is reflected in 'sustainable development' introduced into the public debate with the World conservation strategy in 1980 and popularized by the World Commission on Environment and Development Report "Our Common Future"in 1987. The report issued by the Brundtland Commission, defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Sustainable development implies that economic activity recognises the stresses imposed upon environmental resources by current technology and social demands and the limited ability of the biosphere to meet the needs of a growing world population. The Brundtland Commission Report recognises that local economic development can affect the environment at regional, national and global levels. Economic activity which degrades the environment is not biologically sustainable and thus cannot be, in the long-term economically sustainable. The low priority that has been given to developing and implementing sustainable systems is a reflection of the low weight given to future costs and benefits in presently used economic calculations (Fearnside, 1989). The result is destruction of the forest, along with its potential for sustainable production through forestry management.

The term "sustainable development of forests" is much broader and is concerned with integrated forest management maintaining the ecological integrity of the forest environment, than as compared to sustained yield which means a perpetual (or annual) flow of timber. Forests are sustainable when people can replace or conserve forest qualities they otherwise would deplete (Romm, 1994). During recent times forests have been recognised as reservoir of genes and biodiversity. Forests, predominantly the tropical forests, have been identified as the source of timber. However, the process of logging have been shown to be detrimental towards biodiversity. The large economic value of non-timber products and services should be recognised (Poore and Sayer, 1991), the rapidly growing industry "ecotourism" being one of them. All the non-timber services viz. ecological services, eco-tourism and biodiversity should be taken into account when management plan of a particular area is being prepared. This aspect needs rigorous implementation in our country where management plans are still made in terms of revenue they will generate in due course of time. Each area should be surveyed and evaluated on its merits and then managed accordingly making it sustainable in due course of time.

Society and the Sustainable Forests

Forest resources decline when their use exceeds their growth. The rate of use depends upon the level of human need. It is related to population pressure on the forest and human willingness and ability to employ substitutes for forest resource use. The rate of growth depends upon the levels and qualities of growing stock that people are able to maintain (Ghimire, 1989).

Two aspects of the forestry sector's contribution to sustainable development distinguishes it from others concerned with natural resource management (Miranda *et al.*, 1990). First, forestry has evolved from tree production to management of vast and complex ecosystems with a wider set of concerns - the provision of a broad range of forest products, revenue generation, community forestry and local environmental benefits. The forestry sector must protect the resources and simultaneously must provide opportunities for its use. Recent experiences have shown that there is more potential for success where the Forest Department introduces joint management of forest land and providing greater access to the forest produce by local people (Anon., 1989; Arnold, 1991; Roy, 1992).

Sustainable development by its very implication is tailored to a given situation. People's participation in this activity needs an additional channel of communication - a micro-communication system where a two-way interaction between the communicator and the receiver is to be nurtured and developed through non-governmental groups and the scientific community. Environmental considerations cannot be separated from socio-economic and socio-political realities and the prevailing value system related to growth and development (Ramakrishnan, 1991). Sustainable development in economic terms would lead to an "economic system in which the number of people and the quantity of goods are maintained at some constant level, which is ecologically sustainable overtime, and meets at least the basic needs of all members of the population" (Miller, 1990).

Site specific and transparent techno-extension strategies would motivate communities in self-governance towards sustainable development (Pathan, 1994). While managing resources sustainably, a policy that focuses on the conservation and protection of resources must take due account of those who depend on the resources for their livelihood. For increasing productivity, conservation of biodiversity and to reverse the current trends of forest depletion research support is urgently needed (Tewari, 1990, 1994). The strategy to ensure sustainable development has atleast four important elements: it has to be ecologically harmonious and economically efficient, and must aim at local self-reliance and offer equity with social justice (Khoshoo, 1992). Sustainability in simpler terms means commitment to future for society.

Sustainable development of Forests and Management

Forests are dynamic and generally the ecosystems recover quickly if disturbed, and are able to withstand a wide range of natural disturbances such as fire, insects, diseases and minor changes in climate. These disturbances are an integral part of the natural cycle of succession in forest ecosystems. However, forests must also withstand with disturbances due to human activities. Botkin and Talbot (1992) have concluded that much or most use of forest resources is not sustainable. According to them non-disturbance by human is essentially the only sustainable form of development for tropical forests.

Traditionally foresters have aimed at managing forests on the basis of sustained yield. However application of the concept of sustainable forest land management requires that a narrow vision of industrial timber flows be expanded to include all forest resources, especially as non-timber outputs and benefits are becoming more important to society as a whole. The capability of the forest land base to provide other resources and benefits should not be seriously impaired by use for commercial timber production alone. Forestry practices must also provide for the protection within publicly acceptable and biologically sustainable limits of other environmental concerns such as water and air quality, wildlife, habitat, scenic and aesthetic values. Any negative impacts of local forest activities on regional, natural ecosystems must be recognised or preferably eliminated.

Sustainable forest land management is thus which ensures that the use of any forest resources is biologically sustainable and will not impair the biological diversity or the use of the same land base for any other forest resource in the future. The level of use at which forest resources are sustainable is also quite directly influenced by effectiveness and intensity of management of those resources. Investment in more effective management can raise the level of sustainable outputs (Little, 1990). In a recent communication, Griss (1993) has emphasised the need of fundamental changes in the approach to forest management. Increased attention is required to non-timber values, changing roles and responsibilities, public participation and research. However, involving the public in forest management is a complex issue that requires different solutions for different problems (Griss, 1993). Webster (1993) suggested different approaches to sustainable development of forest resources and has discussed the relationship of sustainable development for forest resources to new technology.

Conclusion

So far societies have placed great emphasis on economic development. But the past decade has witnessed a heightened awareness of the serious environment degradation caused by the use of increasingly powerful technologies and by the consumptive demands of a growing world population. The practice of sustainable development to meet "the needs of the present without compromising the ability of the future generations to meet their own needs" is a challenging task.

All human activities have environmental consequences and the challenge of sustainable development of the forest sector lies in reducing the negative impacts of forest sector and other industrial activities to levels that are within the tolerable limits of forest ecosystems. This would require, for example, adjusting harvesting practices to prevent impairment of ecosystem. Efforts be made seriously to reduce the effluents from manufacturing units to environmentally acceptable levels. There is an urgent need to increase the forest land productivity through improved management of forests and forest plantations as well as reduce losses from fire, insects and diseases so that more forest land is available for other uses without a reduction in overall timber flow.

There is an urgent need of international co-operation in reducing pollutants from industrial and consumption activities that cause forest decline. Time has come for the society to ensure that, while attempting to satisfy current demand, we bequeath a healthy environment and natural resources to meet the needs of future generations.

SUMMARY

The world's population, now eight times what it was at the beginning of the last century, has more than tripled in this century alone. Even greater is the increase in scale and intensity of human activity. All these developments have damaged and deteriorated the ecological systems and natural resources. There is an urgent need of bequeathing a healthy environment to future generation. This requires amongst others the management of forests on a sustainable basis. Forest sustainability depends upon how people define the forest they want, the area and time period over which they assess the balance between gains and losses in forest conditions, the means they employ, and for and by whom these means should be employed. Sustainability becomes an issue when disparities arise between what the forest people want and what actually prevails.

सदा बना रहने वाला विकास और वनों का प्रबन्ध

यू०के० बनर्जी

सारांश

संसार की जनसंख्या पिछली शताब्दी के आरम्भ की संख्या से आठ गुणी, इसी शताब्दी में पहले से तिगुनी से भी ज्यादा हो गई है । इससे भी कहीं ज्यादा मानव की क्रियाशीलता के पैमाने और चण्डता में वृद्धि हुई है । इन सभी विकासों ने पारिस्थिकीय प्रणालियों और प्राकृतिक संसाधनों को हानि पहुँचाई और इनका ह्रास किया है । भविष्य की पीढ़ियों को स्वस्थ पर्यावरण दाय स्वरूप देने की अब तत्काल आवश्यकता है । इसके लिए अन्य बातों के अलावा सदा बना रह सकने वाले आधार पर वनों का प्रबन्ध करने की जरूरत है । वनों का बने रह सकना इस पर निर्भर है कि लोग उन्हें कैसा वन चाहिए इसकी परिभाषा, तथा वह क्षेत्र और उस समय पर जिसमें वे वन दशाओं में होने वाले लाभ और हानि में संतुलन होने का आंकलन करते है, वे उपाय जिन्हें वे उपयोग करते हैं, तो वे लोग जिनके द्वारा इन उपायों को काम में लाया जाना चाहिए । बना रह सकने की बात उस समय विवाद प्रश्न बन जाती है जब इस बात में अन्तर पड़ जाता है कि वन वाले क्या चाहते हैं और वास्तव में हो क्या रहा है ।

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Snippets RECYCLE OF CARBON

Allen Savory, a botanist who has studied areas of North America and Africa that once supported thousands of large animals such as bison, has concluded that high concentrations of cleft-hooved animals may be necessary on grass lands to cycle carbon into the ground. Savory began with a prejudice against grazing cattle, but concluded through his research that rightly bunched animals concentrate nitrogen, giving plants and grasses a strong start. When a herd of animals moves to a new area, the cycle is repeated. In an experiment in Nevada, raising a range allotment from 70 to 1,000 animals improved the condition of range.

- Source: *Forest Products Journal, Dec., 1995.*

BIOMASS PRODUCTION AND MINERAL CYCLING IN PLANTATION ECOSYSTEMS OF *EUCALYPTUS* HYBRID IN HARYANA

2. DISTRIBUTION AND CYCLING OF NUTRIENTS

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Introduction

Nutrients management has been well recognised since early times, which has become highly relevant with the advent of commercial forestry, where there is always a thrust to increase the production and biomass removal besides maintaining the site fertility. Because of short coppice rotation as well as whole tree harvesting, there is need to understand the nutrients distribution in various plant parts and also the nutrient cycling, especially in short rotation plantation ecosystems. Keeping in view, a study on biomass production and cycling of nutrients was undertaken in *Eucalyptus* hybrid plantations raised in Saraswati Range of Kurukshetra Forest Division of Haryana.

Biomass production and its distribution among various tree components for 4, 6, 8 and 10 year old plantations have been published earlier (Tandon *et al.*, 1993). The nutrient distribution among various tree components, the amount of nutrients removed permanently from the site by exploitation and the quantity of nutrients returned to the soil in these ecosystems, forms the subject matter of this paper.

Study Site

The studies were undertaken in Saraswati Range of Kurukshetra Forest Division. The soil of the area is fine loamy with high pH and poor to moderate nutrient status. Some of the area remains waterlogged during monsoon. Climate is semi-arid tropical with scorching hot summer and cool winter. The mean annual minimum and maximum temperature varies between 4.5°C to 43.3°C and the average annual rainfall of the area is 567mm (based on 1966-1985 data).

Method

The field study was conducted, using Stratified Tree Technique and is described in detail in the earlier study (Tandon *et al.*, 1993). In all 17 trees were sampled (3 to 5 trees from each plantation). The fresh weight of different biomass components was recorded in the field and representative samples of known weight were collected for estimation of dry weight and chemical analysis.

Two litter plots (10 m x 10 m) were laid out in each plantation and all the litter lying on the plots was swept clean. Litter was collected from these plots for a period of one year at quarterly interval. Leaf, twig and bark were separated and weighed in the field. Litter samples were also brought to the laboratory for dry weight estimation and chemical analysis. The plant part and litter samples, after being oven dried and powdered were analysed for N, P, K, Ca and Mg using standard laboratory technique. Phosphorus was estimated by Molybedate Blue Method using Spectrophotometer and Potassium and Calcium were estimated by Flame Photometer (Vogel, 1961). Magnesium was precipitated as Magnesium Ammonium Phosphate and titrated against standard NaOH and Nitrogen was estimated by Kjeldahl's Method (Loomis and Shull, 1937).

Results

Nutrient Distribution : In order to determine the nutrient cycling in these plantations, the actual amount of nutrient accumulated in the aerial organs of these plantations was estimated and is given in Table 1. The increase in nutrient content of a standing crop with stand age has direct bearing on the total biomass of forest stand. Thus the total amount of nutrients accumulated in the above ground biomass ranges from N, 78.4 kg/ha to 341 kg/ha; P, 1.9 kg/ha to 95 kg/ha; K, 36.8 kg/ha to 198.7 kg/ha; Ca, 69.9 kg/ha to 293.1 kg/ha and Mg, 25.4 kg/ha to 139.5 kg/ha in these plantations. In general, maximum amount of P, K and Mg is accumulated in bole while maximum Ca is held up in bark at all ages. Accumulation of N was higher in leaf in younger plantations but as the stand reaches maturity, higher accumulation of N was observed in bole.

Litter Production : The estimated annual litter production per unit area (kg/ha) is shown in Table 2 along with percentage contribution of each litter component to the total litter. A total of 4565, 5242, 10236 and 9952 kg/ha of litter was produced at ages 4, 6, 8 and 10 years respectively. As regards the percentage contribution of different litter components, leaf contributed maximum of the total litter (73 to 82 per cent) while that of twig and bark it varies between 17 to 18 per cent and 0.8 to 9 per cent respectively.

Annual Nutrient Return : The total nutrient returned annually to the soil by different components (kg/ha) are presented in Table 3. Among the five nutrients studied, there was maximum return of Nitrogen followed by Calcium. The annual return of N was 38.3, 43.6, 78.8 and 74.7 kg/ha at 4, 6, 8 and 10 years old plantations respectively. The annual return of P was minimum at all ages. Leaf contributes the bulk of litter (73 to 82 per cent), thus maximum amount of nutrients are returned to the soil through leaf litter.

Nutrient Cycling : The data reveals that the pattern of annual mineral cycling (uptake, retention and release) varies at different ages (Fig. 1 to 5). Though large amount of nutrients are accumulated in the biomass components of the standing crop, the annual retention of N, P, K, Ca and Mg is much less than return to the soil through litter fall. While in case of P, the retention and release is almost same.

Whole tree harvesting : The perusal of the data (Table 4) shows, that harvesting of the crop at the age of 10 years in this locality would result in the removal of 341, 9, 199, 293, 139 kg/ha of N, P, K, Ca and Mg respectively. However, if only bole and fuelwood are removed the loss would be reduced to 255, 8, 153, 215 and 121 kg/ha of N, P, K, Ca and Mg respectively.

Table 1

Mineral contents in component plant parts (kg/ha) at different aged Eucalyptus hybrid plantations.

Nutrients	Component Plant parts	Age(years)			
		4	6	8	10
N	Bole	20.52	28.08	84.50	171.20
	Bark	5.40	8.40	23.10	43.20
	Leaf	27.20	37.80	45.90	60.90
	Twig	16.50	20.44	34.22	25.48
	Branch	8.74	17.16	18.63	40.32
	Total a.g.b	78.36	111.88	206.35	341.10
P	Bole	0.648	1.30	4.55	5.35
	Bark	0.306	0.45	1.89	1.94
	Leaf	0.288	0.28	0.59	0.60
	Twig	0.330	0.31	0.83	0.78
	Branch	0.342	0.42	1.05	0.78
	Total a.g.b.	1.914	2.76	8.91	9.45
K	Bole	7.56	12.96	39.00	64.20
	Bark	5.95	6.60	22.40	66.96
	Leaf	5.76	8.20	22.15	19.25
	Twig	8.36	13.72	28.91	27.04
	Branch	9.12	10.40	18.63	21.28
	Total a.g.b.	36.75	51.88	121.09	198.73
Ca	Bole	1.08	2.16	6.50	42.80
	Bark	16.83	24.60	126.00	131.76
	Leaf	18.40	14.60	38.07	37.10
	Twig	20.24	24.36	61.63	41.08
	Branch	13.30	10.40	24.30	40.32
	Total a.g.b.	69.85	76.12	256.23	293.06
Mg	Bole	8.64	19.44	45.50	85.60
	Bark	1.87	3.90	11.90	20.52
	Leaf	4.32	5.00	6.48	8.40
	Twig	3.74	4.20	14.16	10.40
	Branch	6.84	8.84	9.72	14.56
	Total a.g.b.	25.41	41.38	87.76	139.48

Table 2

Litter Production in different aged plantations (kg/ha) of Eucalyptus hybrid

Age	Leaf		Twig		Bark			Total
(yrs)	(kg/ha)	(%)	(kg/ha)		(%)	(kg/ha)	(%)	
4	3759	82	806		18	-	-	4565
6	4298	82	904		17	40	0.8	5242
8	7850	77	1752		17	634	6.0	10236
10	7303	73	1801		18	848	9.0	9952

Table 3

Nutrient Content in litter (kg/ha) in different aged Eucalyptus hybrid plantations

Age		N	P	K	Ca	Mg
	Leaf	36.8	0.49	11.7	24.8	9.8
4	Twig	1.5	0.06	0.97	7.2	0.89
	Bark	-	-	-	-	-
	Total	38.3	0.55	12.67	32.0	10.69
	Leaf	41.7	0.56	16.3	25.8	12.9
6	Twig	1.8	0.05	1.6	5.0	1.9
	Bark	0.05	0.002	0.02	0.2	0.11
	Total	43.55	0.612	17.92	31.0	14.91
	Leaf	74.6	1.1	34.5	58.9	21.2
8	Twig	3.0	0.12	2.6	13.0	3.15
	Bark	1.2	0.04	0.57	6.28	1.8
	Total	78.8	1.26	37.67	78.18	26.15
	Leaf	70.1	1.0	28.5	43.1	15.3
10	Twig	3.2	0.11	2.2	12.2	2.7
	Bark	1.4	0.05	0.68	3.8	1.7
	Total	74.7	1.16	31.38	59.1	19.7

Discussion

The increase in nutrient content of standing crop has a direct bearing on the total biomass of the forest stand. As such the nutrient content accumulated in various tree components vary considerably. In general, the accumulation of nutrients is higher in leaf in younger plantations, but as the stand increases in age, major portion of nutrients are stored in bole due to increase in non-photosynthetic biomass, while maximum calcium is held up in bark (Table 1). Present study also reveals that the accumulation of different nutrients increases manifold from young plantation (4 years) to mature crop (10 years). These observations are in general agreement with those reported earlier for *Eucalyptus globulus* (Negi and Sharma, 1984),

Figs 1-5

Nutrients cycling in *Eucalyptus* hybrid plantations

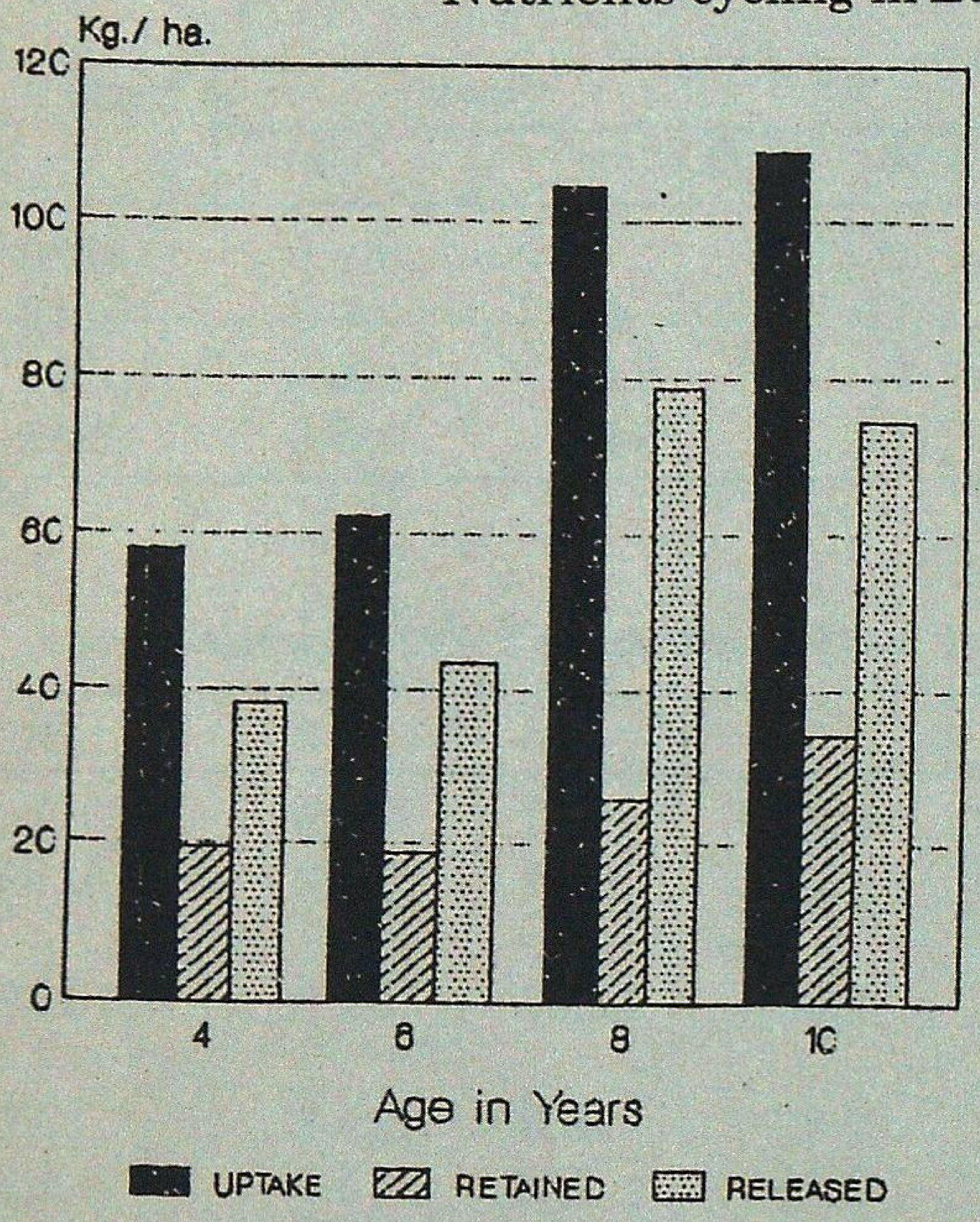

Fig. 1 - Nitrogen

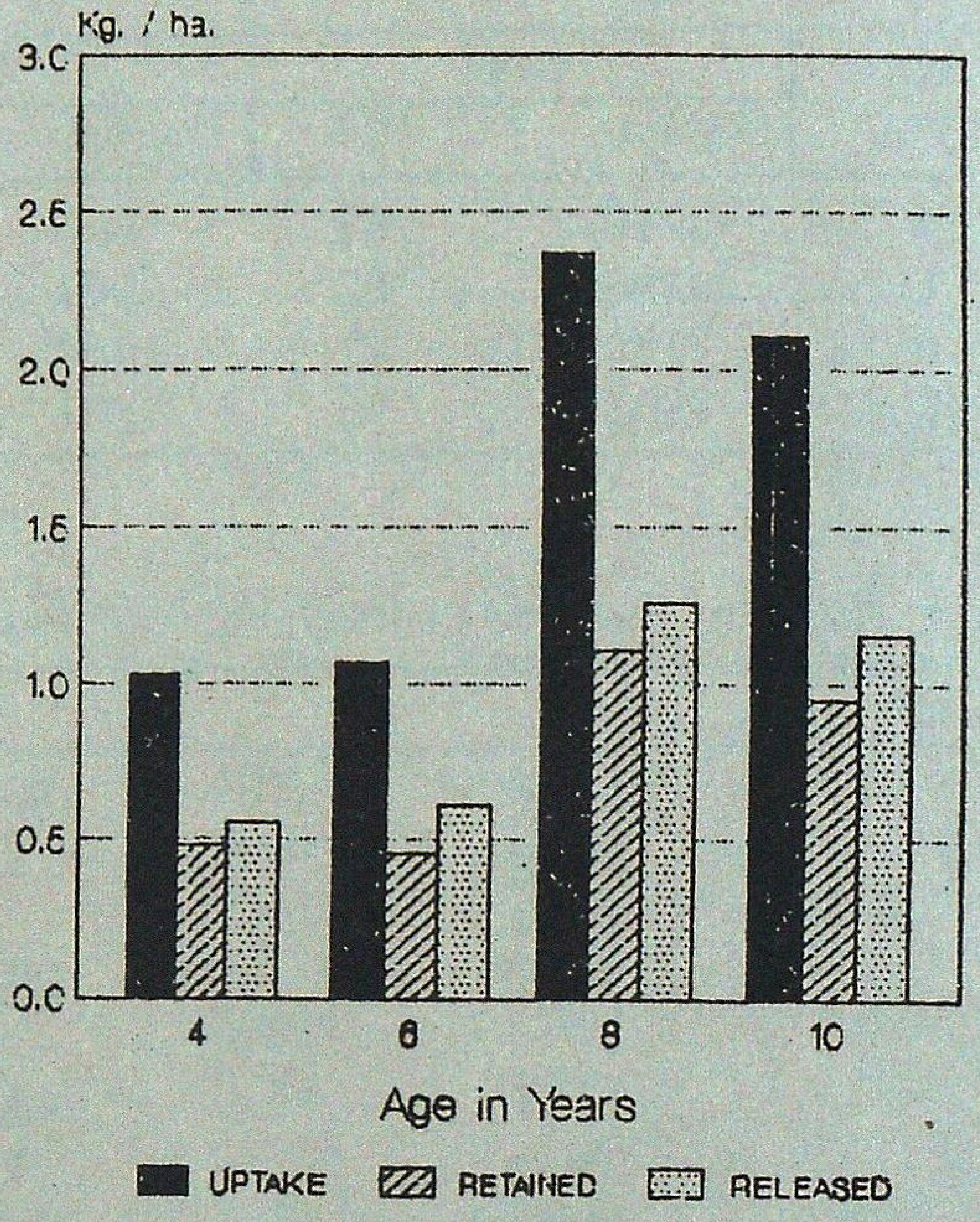

Fig. 2 - Phosphorus

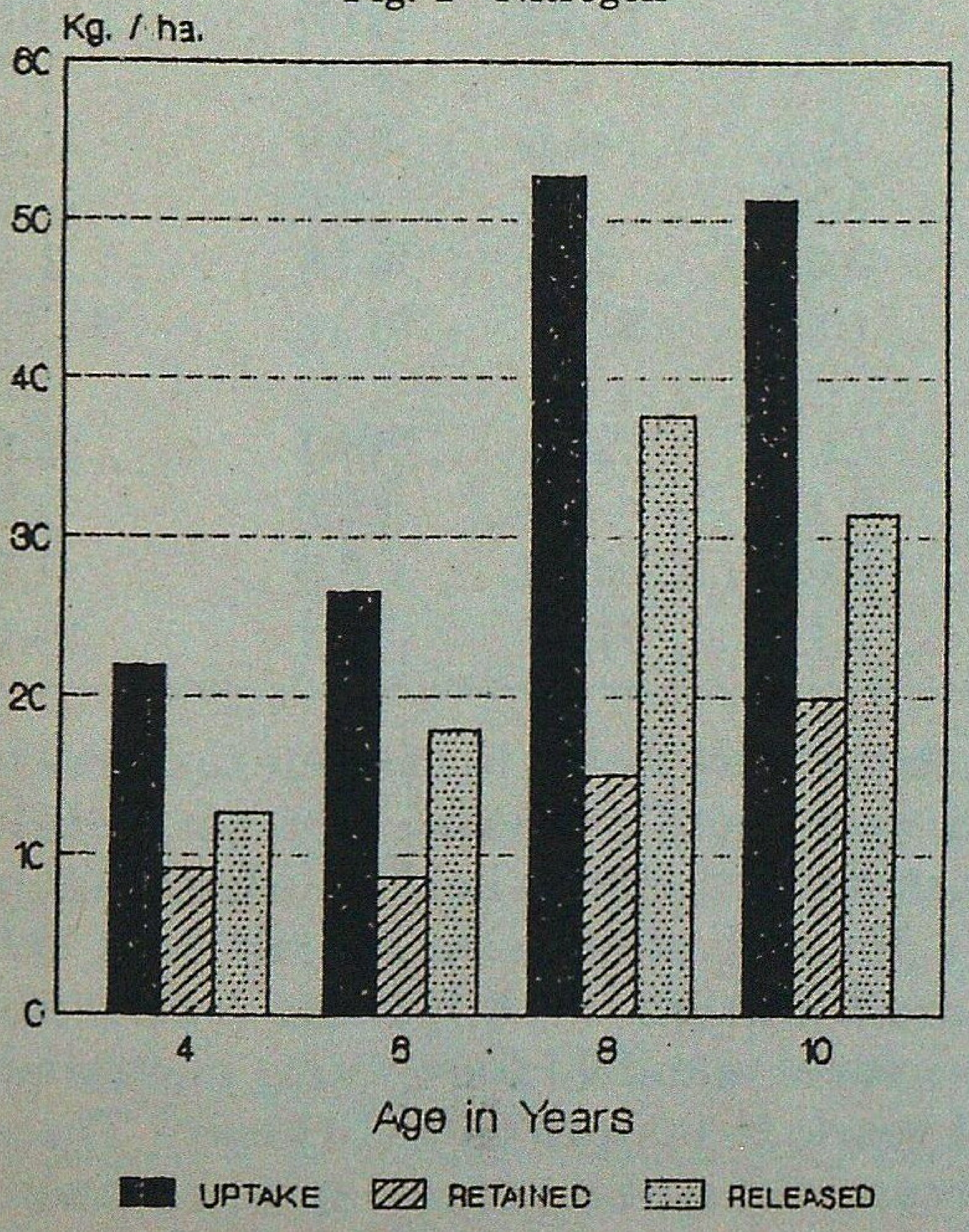

Fig. 3 - Potassium

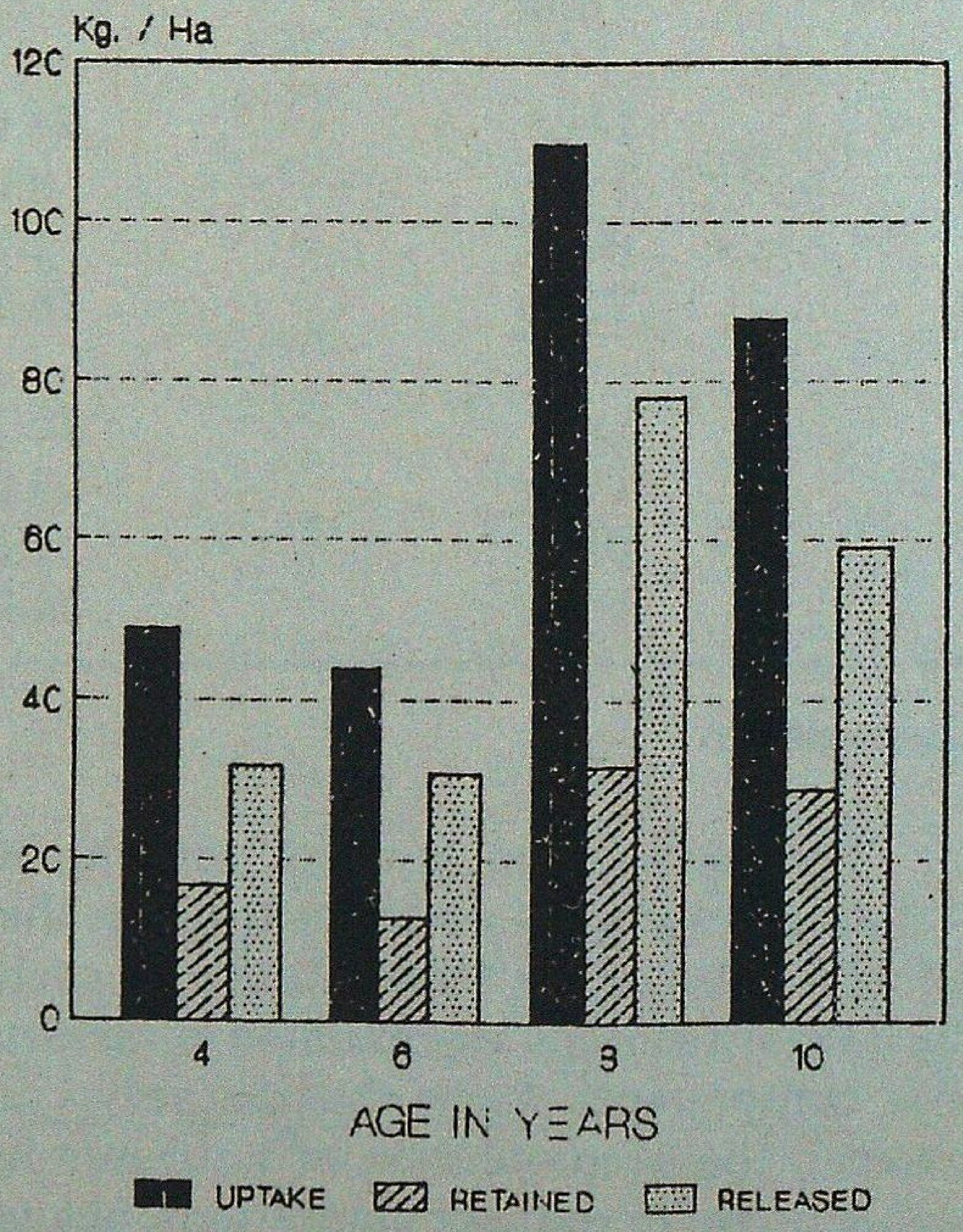

Fig. 4 - Calcium

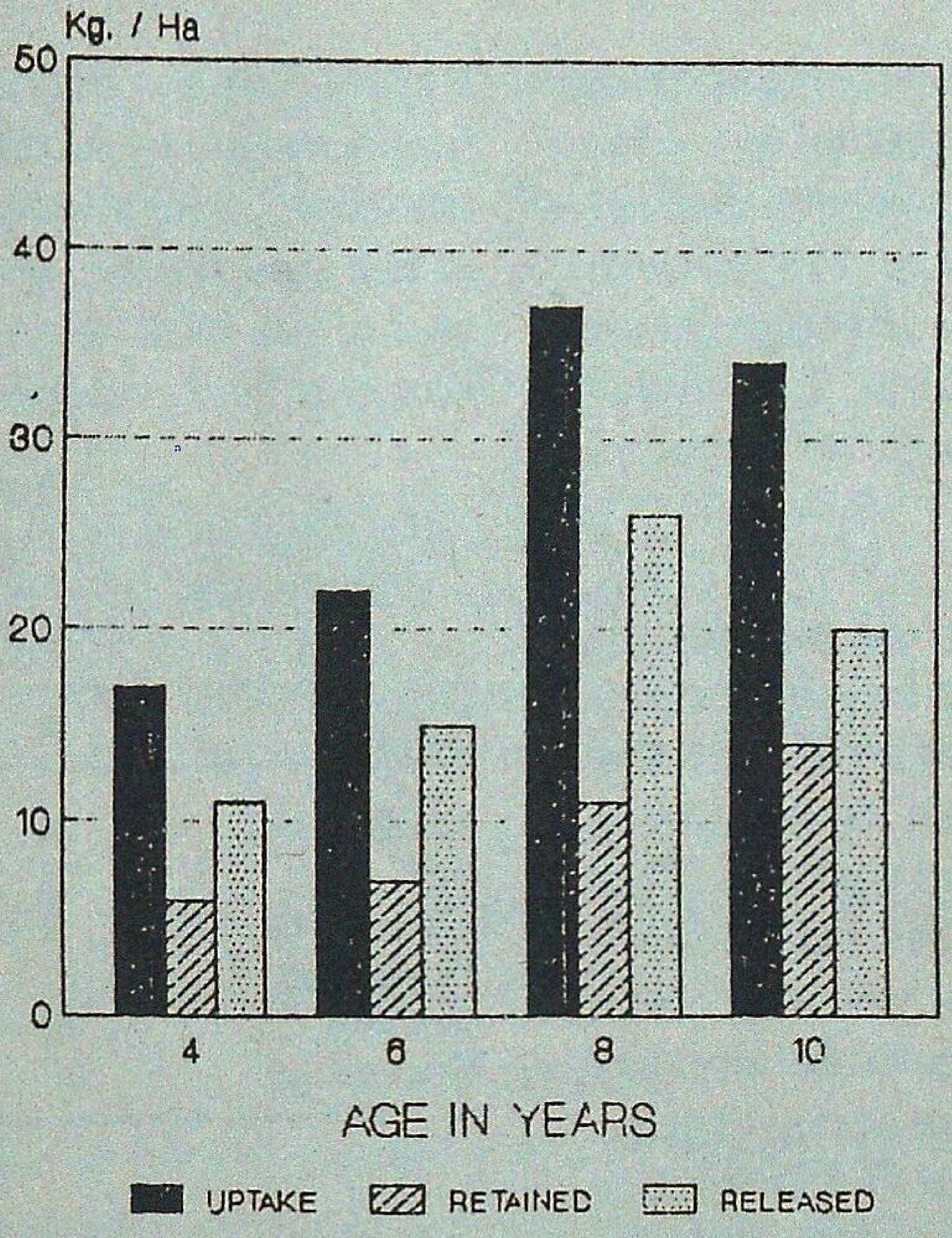

Fig. 5 - Magnesium

Eucalyptus hybrid (Pande *et al.*, 1987, 1987a), *Eucalyptus grandis* (Tandon *et al.*, 1991), *Eucalyptus* hybrid (George, 1977), *Dalbergia sissoo*, (Sharma *et al.*, 1988) and *Populus deltoides* (Tandon *et al.*, 1991).

The perusal of data reveals that maximum leaf fall (in terms of percentage) occurs in younger plantations, possibly due to faster growth of canopy. There is increase in litter production with stand age, however, the higher litter produced at the age of 8 years is attributed to higher number of trees in the litter plots at this age. As already mentioned, out of the total litter produced, leaf contributes 82 per cent at the age of 4 years, which decreases to 73 per cent at the age of 10 years (Table 2). Tandon *et al.*, (1991), in their study on *Populus deltoides* reported 85.2 per cent litter fall in a young stand (3 years), which decreases to 69.5% at the age of 9 years.

Though, substantial amount of nutrient elements are accumulated in the biomass components, the annual retention within the biomass components is less than that returned to the soil. The perusal of Figs. 1 to 5 shows that there is maximum return of Nitrogen followed by Calcium, Potassium and Magnesium. The annual return and retention of Phosphorus was almost same at all ages. It may be observed from, Table 5 that the annual retention of Nitrogen is maximum (34 kg/ha) followed by Calcium (29 kg/ha), Potassium (20 kg/ha) and Magnesium (14 kg/ha). Thus a greater fraction of annual uptake ranging from 50 per cent to 69 per cent is returned to the soil annually through litter fall indicating that annual needs of *Eucalyptus* hybrid are less in this locality as compared to the returning percentage of this species at the same age in Tarai Region of Uttar Pradesh, which varies between 9 to 34, resulting in the drain of nutrients at a faster rate in this locality having almost the same biomass. As mentioned earlier, bulk of litter is returned to the soil in the form of leaf, thus maximum amount of nutrients are also returned through this components. Seth *et al*. (1963) and Srivastava *et al*. (1972) both studied on mineral return through litter fall, have demonstrated that leaf litter returns substantial amount of various nutrient elements.

Trees take up large quantities of nutrients, although substantive portion of the nutrient uptake is returned back to the soil through litter fall, an appreciable amount are removed in harvesting. This drain of nutrients increases with more intensive utilization. The present data shows (Table 4) that considerable amount of nutrients are tied up in the aerial organs of the trees, which are removed from the site by way of harvesting and removal would depend upon the intensity of harvesting. It is therefore imperative that foresters establish the rate and amount of nutrients that are removed from a variety of sites under short coppice system as well as with whole tree harvesting, they could then develop prescriptions to minimize the deleterious effect. Certainly soil amelioration by fertilization is an acceptable alternative for meeting the nutrient needs of the tree species. Additionally harvesting technique that leaves foliage and bark on site can be developed.

Table 4

Above ground biomass and total accumulation of nutrients (kg/ha) in different aged Eucalyptus hybrid plantations

Age (yr)	4	6	8	10
A.G.B. (t/ha)	20	35	89	138
Nitrogen	78	112	206	341
Phosphorus	2	3	9	9
Potassium	37	52	121	199
Calcium	70	76	256	293
Magnesium	25	41	88	139

On the basis of the data discussed, it is not possible to calculate to what extent the soil is impoverished as a result of whole tree harvesting, but there is reason to believe that at least in case of poor soils, the decrease in fertility is considerable. The detrimental effect will however be smaller, if foliage is left on the site.

Table 5

Annual Nutrient uptake, retained and returned in Eucalyptus hybrid plantations

Age (yrs)	Biomass (t/ha)	Nutrient pathway	Nutrient (kg/ha)					Source
			N	P	K	Ca	Mg	
10 yrs.	138	Uptake	109	2	51	88	34	Present Study
		Retained	34	1	20	29	14	
		Returned	75	1	31	59	20	
			(69)	(50)	(61)	(67)	(59)	
10 yrs.	142	Uptake	59	11	43	169	16	George (1977)
		Retained	39	10	33	146	14	
		Returned	20	1	10	23	2	
			(34)	(9)	(23)	(14)	(13)	

Note : Figures in parenthesis refer to the percentage of uptake

Acknowledgements

The authors are grateful to Haryana Forest Department for providing all facilities during collection of field data.

SUMMARY

Mineral cycling in four different aged *Eucalyptus* hybrid plantations has been discussed. The componentwise distribution of nutrients at different ages and the nutrients removed as a result of whole tree harvesting has been presented. A total of 4565, 5242, 10236 and 9992 kg/ha of litter was produced annually at ages 4, 6, 8 and 10 years respectively. Out of the total litter, leaf litter contributed between 73 to 82 per cent, thus maximum nutrients are returned to the soil through leaf litter. Maximum return was observed for Nitrogen followed by Calcium, Potassium, Magnesium and Phosphorus.

हरियाणा की *युकेलिप्टस हाइब्रिड* रोपवन परिस्थिति संहतियों में जैवपुंज उत्पादन और खानिजीय चक्रण

वी०एन० टंडन, एम०एस० नेगी, डी०सी० शर्मा व एच०एस० रावत

सारांश

इस अभिपत्र में चार विभिन्न उम्र *युकेलिप्टस* हाइब्रिड रोपवनों का खनिजीय चक्रंण विवेचित किया गया है । विभिन्न उम्र रहने पर अवयववार पोष्यहारों का वितरण और पूरा पेड़ काटे जाने पर परिणाम स्वरूप उससे निकले पोष्याहारों को प्रस्तुत किया गया है । 4, 6, 8 और 10 वर्ष की उम्र पर क्रमशः 4565, 5242, 10236 और 9992 किग्रा/हेक्टे० आस्तरण वार्षिक उत्पन्न हुआ । कुल आस्तरण में से पर्णास्तरण का योगदान 73 से 82% के बीच रहा, इस प्रकार अधिकतम पोष्याहार मृदा में पर्णास्तरण के माध्यम से ही वापस आता है । सबसे अधिक वापसी नाइट्रोजन की होती है, इसके बाद क्रमशः कैलशियम, पोटाशियम, मैगनिशियम और फास्फोरस की ।

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Snippets TREE DISEASE

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Source: *ITTO, Sept., 1995.*

VEGETATIVE PROPAGATION OF JUVENILE CHIR PINE CUTTINGS UNDER INTERMITTENT MIST

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Introduction

Chir pine (*Pinus roxburghii*) is an important commercial species of subtropical Himalaya. The species yields valuable timber, packing cases and resin products and is consequently over exploited. Of late, the pine is gaining recognition as an important social forestry species because of its multiple utility, easy establishment and being least exacting among the Himalayan conifers. Other regeneration methods are required if the species is to have a commercial future. Vegetative propagation can benefit cloning of superior individuals in short time. Chir pine is however considered as difficult-to-root (Bhatnagar, 1977; Sood, 1979) and hence the present studies on cutting propagation of the species. The species is known to produce multiple orthotropic shoots.

Materials and Methods

The experiment was conducted in a mist unit (17.3 x 6.3m), College of Forestry, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni during 1989. The mist operated daily between 07.00 to 18.30 hr for 5s at 10 min interval. Day/night maximum and minimum ambient air temperatures averaged 32±4^{0}C/20±4^{0}C respectively. 1.5 and 6 year old stock growing in nursery beds were sheared by removing their apical tops in February. Cuttings were then prepared form multiple tops (branch blasts) and lateral shoots arising from side of primary axes. Before severing, the selected shoots were wrapped with 3cm wide black adhesive tape about 10-15cm from the tip. These were harvested 4 weeks later on two dates i.e., June 8 and September 12, 1989 and treated with following formulations (Shamet unpubl.) for rooting trials.

1. Control

Rooting Formulations :

2. 0.75% IBA-talc
3. 0.5% IAA-talc
4. 0.25% NAA-talc
5. 1% NAA- Activated Charcoal (AC)
6. 1% IBA- Activated Charcoal (AC)

Chemical additives used (2-6) were 0.5% B-nine +0.1% gallic acid + 10% each of captan and sucrose.

Needles and buds were removed from the lower 5-6 cm portion of the cuttings before sticking. 20 cuttings (10-15 cm long) were assigned to each treatment, there being six rooting formulations. Control cuttings were treated with a half to half (v) mixture of talc and activated charcoal. Cuttings were inserted 4-5 cm deep in polytubes

(6.25 x 12.5 cm) filled with a sterilized river sand. Observations on callusing (%), rooting (%), mean root number and root length (cm) were recorded after 75 days and necessary conclusions made.

Results and Discussion

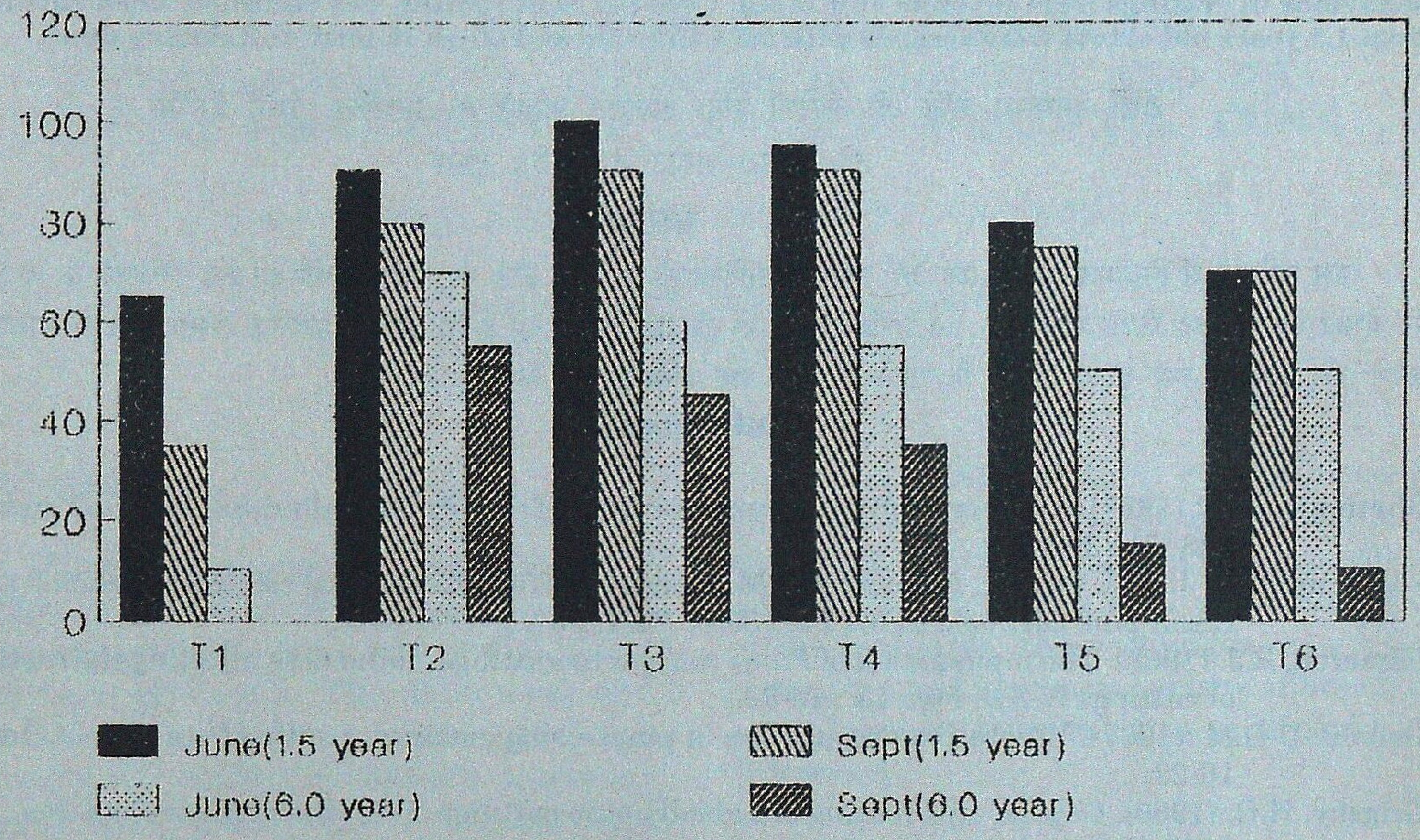
The main limiting factors in rooting of pine cuttings appears to be the supply of rooting harmone (including cofactors), nutrition and fungal decay in rooting beds. There are evidence to suggest that auxin and chemicals like sucrose, captan (Grigsby, 1966; Hare, 1974; Donald, 1987) and B-nine (Read and Hoycler, 1969) improves rooting in many difficult-to-root pine species when combined in an appropriate mixture in rooting powder. It was evident from the Table 1 that some rooting powders resulted in enhanced rooting capacity of the pine cuttings when stuck under optimum environment of a mist unit. Cuttings rooted produsely when these were collected from younger (1.5-years) stock and treated during June (Fig. 1). A highest 100 per cent rooting was recorded when cuttings from younger ortets were treated with 0.5% IAA-talc. It was followed by 0.25% NAA-talc and 0.75% IBA-talc mixtures giving 95 and 90 per cent success respectively. The findings are in agreement with those of Thielges and Hoitink (1972) who reported softwood cuttings (late June) as best for rooting of eastern white pine. However, as far as root system and quality was concerned, application of 0.75% IBA-talc and 0.25% NAA-talc proved effective as compared to

Table 1

Effect of different auxin formulation on rooting of juvenile Pinus roxburghii cuttings under mist

Treatment	Setting Period	1.5 years				6 years			
		Per cent callused	Per cent rooted	Mean roots	Mean root length (cm)	Per cent callused	Per cent rooted	Mean roots	Mean rooted length (cm)
Control	June	20	65	2.0	1.5	15	10	1.3	0.6
	Sept	15	35	1.8	0.7	25	0	-	-
0.75% IBA-talc	June	10	90	6.4	10.5	20	70	4.2	6.3
	Sept	15	80	4.2	5.4	35	55	3.0	3.5
0.5% IAA-talc	June	0	100	4.2	4.5	30	60	5.0	4.9
	Sept	5	90	3.0	3.3	35	45	3.0	3.2
0.25% NAA-talc	June	5	95	6.0	11.2	35	55	4.0	6.8
	Sept	10	90	4.6	6.8	35	35	3.4	3.7
1% NAA-AC	June	15	80	3.2	8.5	30	50	3.6	6.5
	Sept	20	75	2.2	6.0	40	15	2.6	4.6
1% IBA-AC	June	20	70	4.0	6.7	25	50	3.2	3.8
	Sept	15	70	2.4	4.6	45	10	2.5	2.6

Fig. 1



Effect of different auxin formulations on rooting of juvenile *Pinus roxburghii*.

other formulations.

Cuttings from 6 year old ortets rooted to a smaller extent giving better results in June than September. Best rooting success was achieved with 0.75% IBA-talc (70%) followed by 0.5% IAA-talc (60%) and 0.25% NAA-talc (55%) treatments. Donald (1987) had also reported a fairly high rooting success for *Pinus elliottii* (55.6%), *P. muricata* (55.6%), *P. patula* (55.5%), *P. pinaster* (78.2%), *P. radiata* (81.2%) and *P. taeda* (62.2%) when 12-18 cm long branch blasts were treated in 1% IBA+10% captan+10% succore during June.

More or less similar trend was observed in rooting and root quality of autumn planting but with a considerable reduction in its value. Cuttings exhibited higher callusing when these were collected from older ortets and treated with active charcoal based formulations in September. All rooted cuttings survived hardening off via mist reduction and subsequent planting in polythene bags (12.5 x 22.5 cm). These exhibited faster growth rate under long photoperiod of the mist chamber.

The techniques can therefore, be employed for establishing seed orchards, tree improvement and raising superior plantation of the species. In fact, operational production of rooted pine cuttings has long been underway in Asia-Pacific countries and the USA (Cameron, 1968; Hare, 1974; Van Buijtenen *et al.*, 1975).

SUMMARY

The paper deals with the effect of six rooting formulations including control on rooting behaviour of cuttings from juvenile chir stock. Cent per cent rooting was recorded when cuttings from 1.5 years old ortets were treated with 0.5% IAA-talc and stuck in mist unit during June.

बाल सामान्य चीड़ की कलमों द्वारा असंतत् कोहरे के अन्तर्गत वर्धी प्रवर्धन

जी० एस० शामेट व ए०के० हांडा

सारांश

इस अभिपत्र में नियामक सहित छह जड़ उत्पादक संविन्यासों का बाल चीड़ से काटी कलमों का जड़ निकलने के व्यवहार पर प्रभाव का विवेचन किया गया है । 1.5 वर्षीय प्रोर्टेटों से ली गई कलमों को 0.5% इण्डोल एसेटिक अम्ल-टैल्क से उपचारित करने और जून में उन्हें कुहरा ईकाई में रखने से उनमें शत प्रतिशत जड़ें निकल आई ।

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PLANT RESPONSES TO WATER STRESS AND ANTITRANSPIRANTS : CHANGES IN GROWTH AND DRY MATTER PRODUCTION OF *GREVILLEA ROBUSTA* A. CUNN.

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Introduction

As a consequence of competition and differential capacity for drought tolerance tree species are often segregated along moisture gradients. The structural and physiological adaptations associated with drought tolerance of plants are numerous and diverse (Pallardy, 1981), and they have seldom received detailed study in woody species that vary in natural distribution. Although many attributes associated with drought tolerance appear to be more important for plant survival than for high growth rates (Turner, 1986), maintenance of the capacity for gas exchange under drought conditions may favour both survival and productivity.

Initial growth is an important factor in the subsequent survival and development of individual tree species (Nautiyal *et al.*, 1994). The faster growing seedlings have an initial comparative advantage but they react differently to varying soil moisture. In the field, it is not only the absolute value of water deficiency that can be tolerated, but also the response to continuously changing soil moisture that is important for survival (Mazzoleni and Dickman, 1988).

The numerous physiological responses of plant to water deficits generally vary with the severity as well as the duration of the stress. Only the most sensitive processes are altered by a very mild stress. As the stress increases, these changes intensify, and additional processes become affected in accordance to their relative sensitivity to the stress.

The objective of this study was to see potential of the seedlings of *Grevillea robusta* to sustain water stress, and for how long, as well as to see the affect of antitranspirants in favour of prolonging stress tolerance, keeping in view the role of antitranspirants in slowing down the process of transpiration, hence, save the plant from excess water loss. The findings will thus be useful in developing a technology for protecting the seedlings from descication during transportation from nursery to field site as well as help in establishing the seedling in the field by the use of antitranspirants, aiming to make the plantations more successful.

Materials and Methods

Three months old uniform seedlings of *Grevillea robusta* were transplanted in earthenware pots (25 cm) containing a mixture of soil, sand and farm yard manure

(2 : 1 : 1) in the month of April, 1992. These pots were fully charged with water and divided into four groups of 90 pots each with one seedling per pot. After 10 days of acclimatization of seedlings in the pots in open, these were shifted to glasshouse under controlled conditions. Each group of pots were divided into 9 lots with 10 pots in each lot and kept under different water stress conditions created by withholding watering at the interval of 7 days, 15 days, and 30 days, however, one lot was watered daily and treated as control. While 8 lots of each group were treated with the antitranspirants (Sodium benzoate, Malic hydrazide, Phenyl mercuric acetate and Cycocil in two concentrations of 100 and 1000 ppm), the 9th lot was kept untreated.

Growth data were recorded for three month at 15 days interval and the mean values were presented in graphic forms.

Results and Discussion

The soil moisture percentage ranged from 25 per cent to 0.6% under different water stress conditions; the maximum temperature was 42.5⁰C in May and minimum 16⁰C in April. The relative humidity was 80 to 94% at 0.700 and 42 to 71% at 14 hours.

As shown in Fig. 1 the survival percentage decreased with increasing water stress under control as well as under antitranspirant treatments. It was interesting to note that more casualties occur under treatment or treated seedlings as compared to control or untreated seedlings. Again the magnitude of survival of seedlings under antitranspirant treatment was higher in case of 100 ppm concentration than in 1000 ppm concentration, it indicates clearly that higher doses of antitranspirants are more injurious to survival of seedling. The lowest seedling survival was observed in case of phenyl mercuric acetate 1000 ppm concentration. However, no seedling could survive at 30 days watering interval.

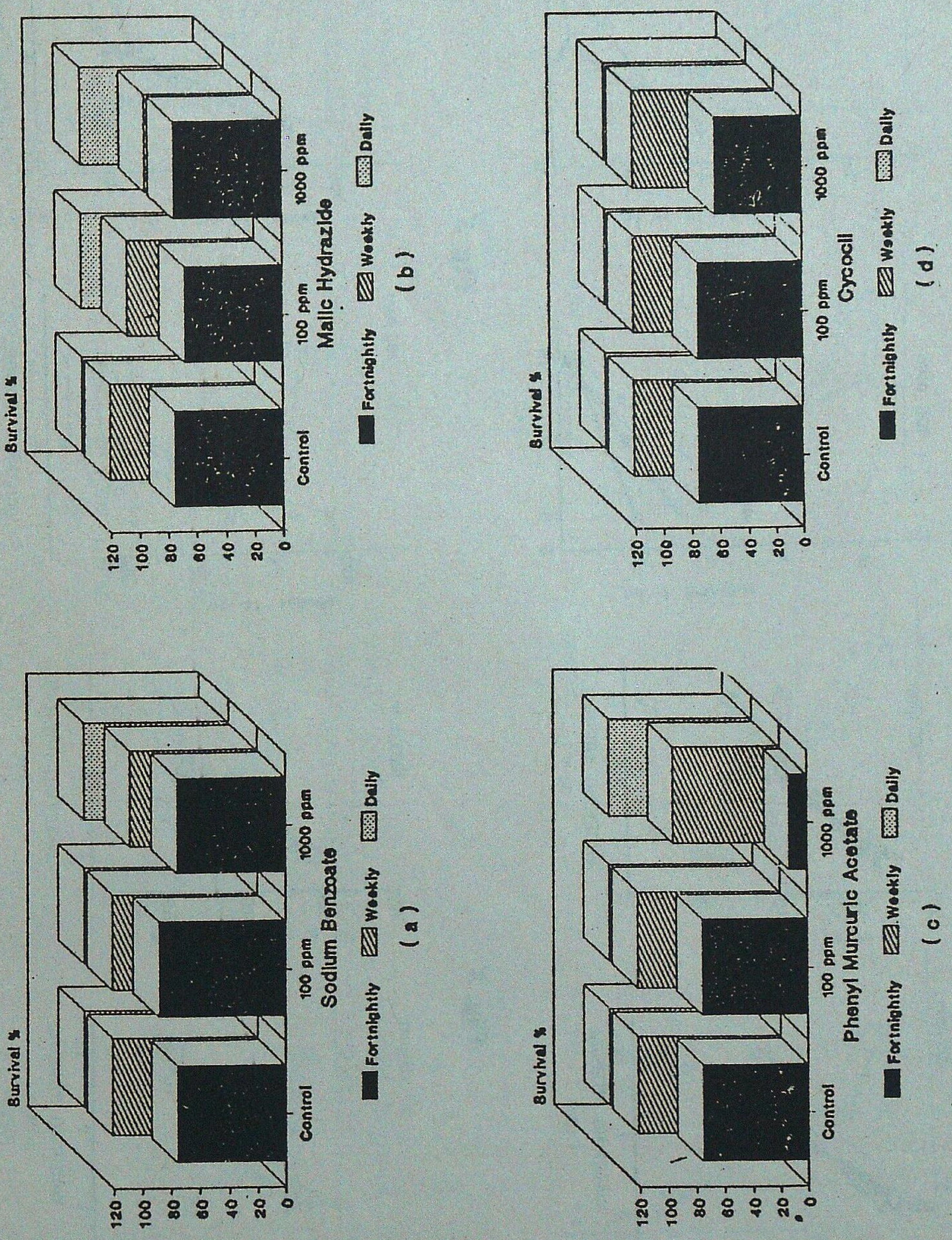
There was a sharp decrease in collar diameter (Fig.2 a, b) and height (Fig. 3 a, b) both from daily to weekly watering interval and subsequently gradual under control as well as under antitranspirants treatment except at higher concentration of phenyl mercuric acetate and cycocil where the decrease was in a straight line.

The height of the plants as well as root length decreased more or less smoothly with increasing water stress under control as well as antitranspirant treatment conditions (Fig. 3 a, b and 12 a, b). The number of branches and leaves also decreased with increasing water stress (Fig. 4 a, b and Fig. 5 a, b) except in phenyl mercuric acetate 1000 ppm where the number of branches increased in fortnightly watering interval than weekly watering interval.

The fresh weight and dry weights of stem, leaves, branches and roots gradually decreased with increasing water stress but the magnitude of decrease was more effective in case of control that is without treatment than under antitranspirant treatment conditions (Figs. 6, 7, 8, 9, 10, 11, 13, 14 a and b).

Water stress or drought has profound effect on growth, yield and plant quality. The first effect of the stress, may well be a loss of turgor that affects the rate of cell expansion and ultimate cell size. Loss of turgor is most probably the process of most sensitive to water stress. The result is the

Fig. 1



Survival percentage and water stress under various treatments

Fig. 2

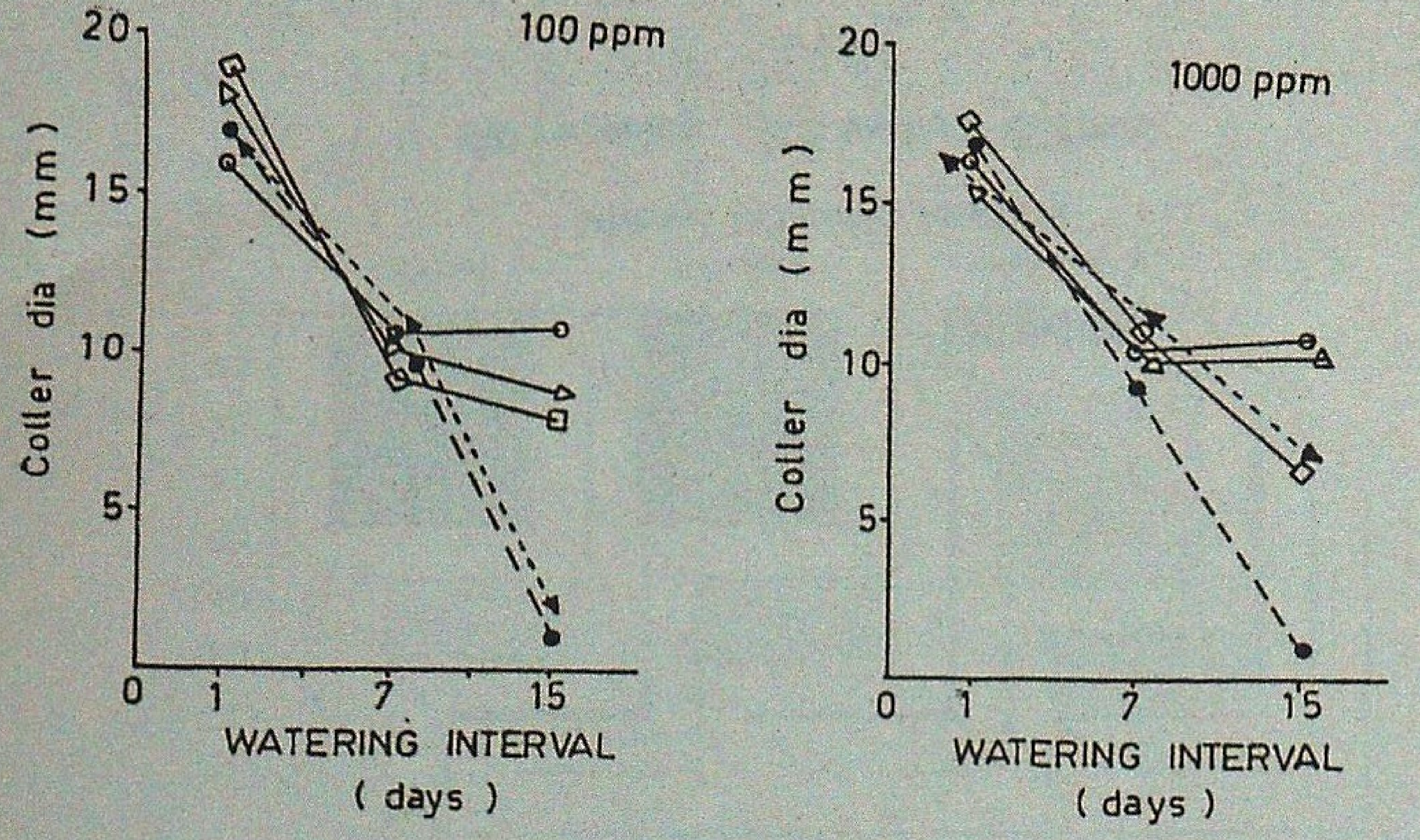


Fig. 4

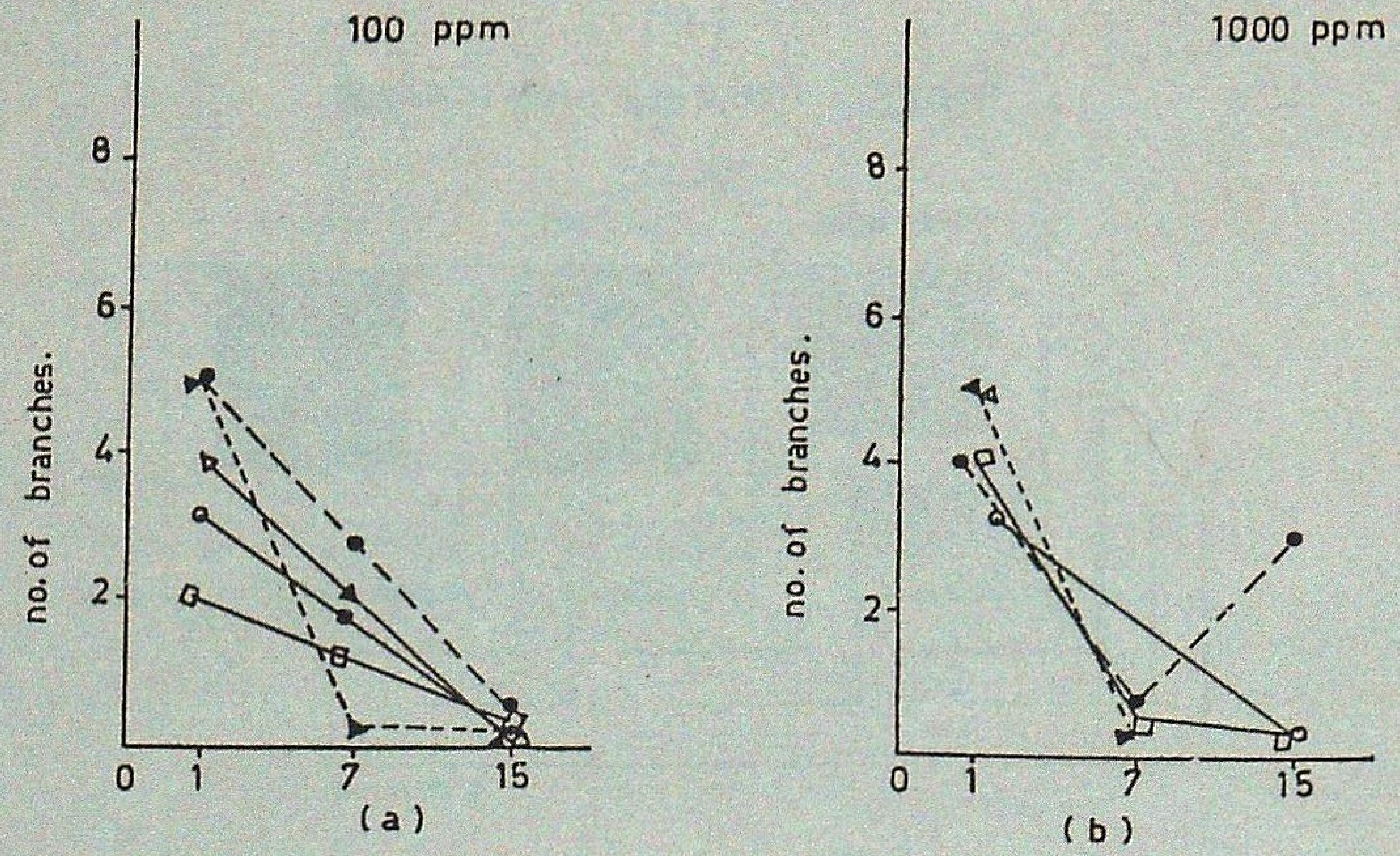


Fig. 3

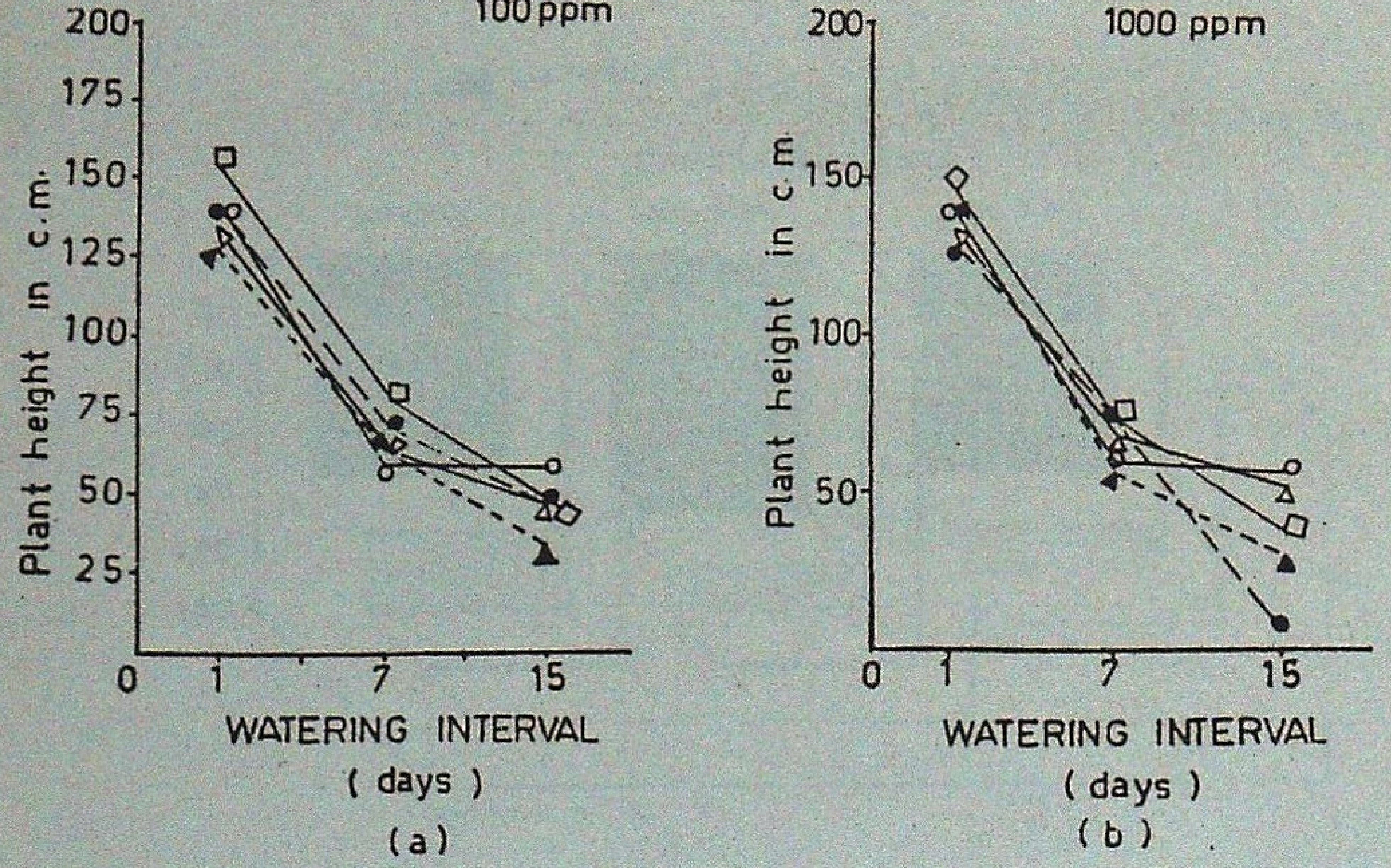
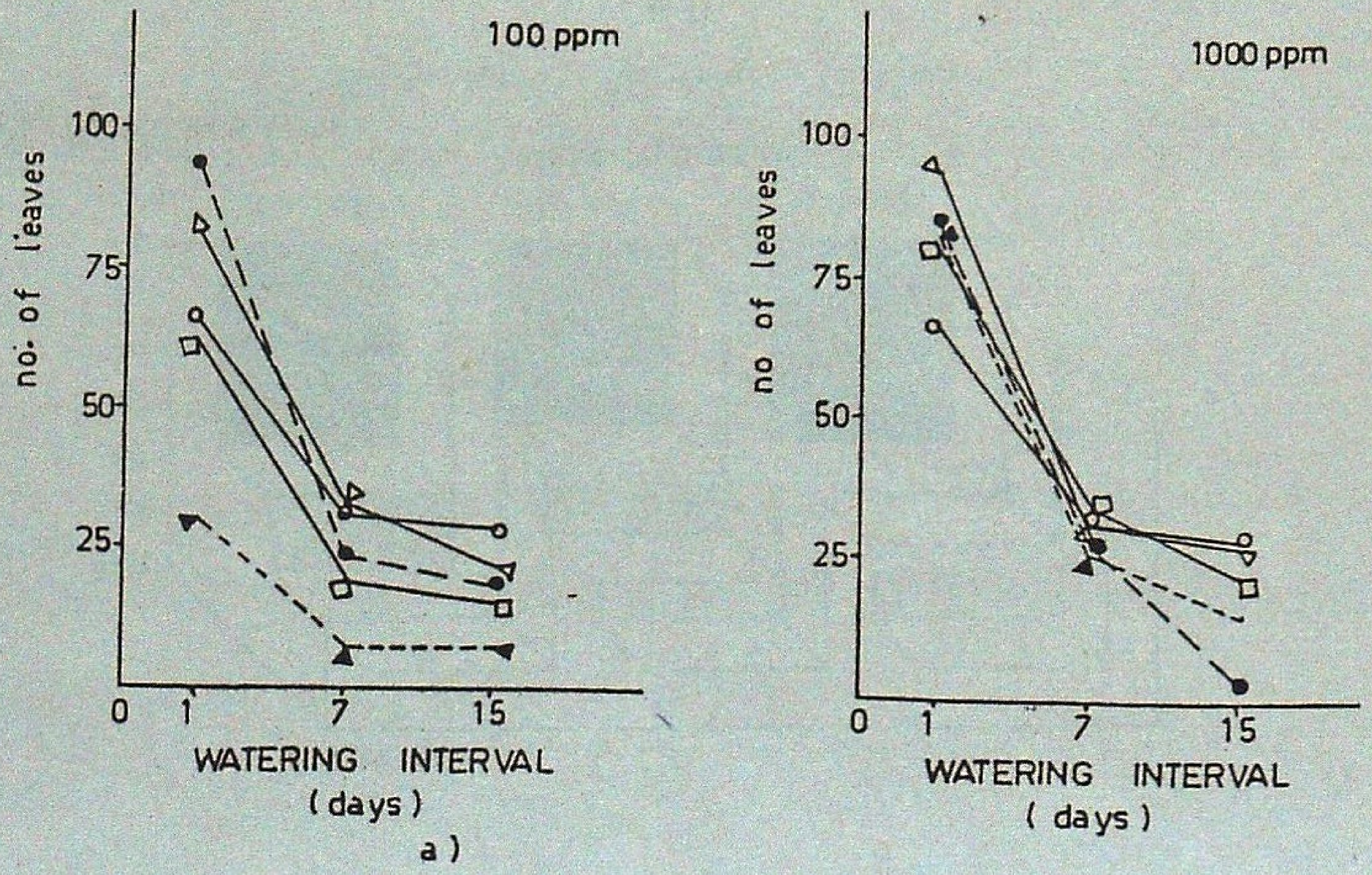


Fig. 5



O- Control; Δ - Sodium Benzoate; - Malic hydrazide; ● - Phenyl mercuric acetate; ▲ - Cyclocil

Fig. 6

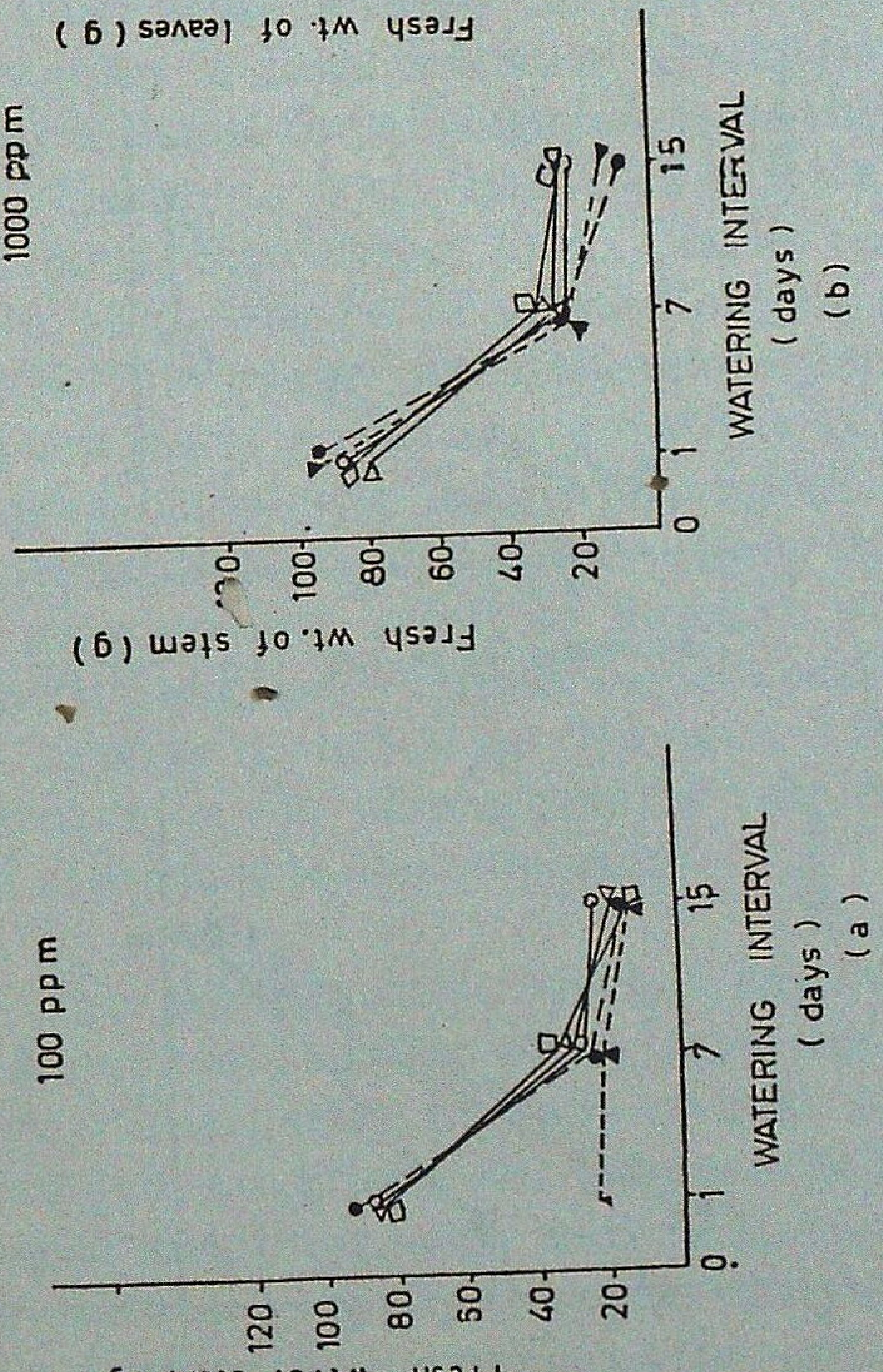


Fig. 7

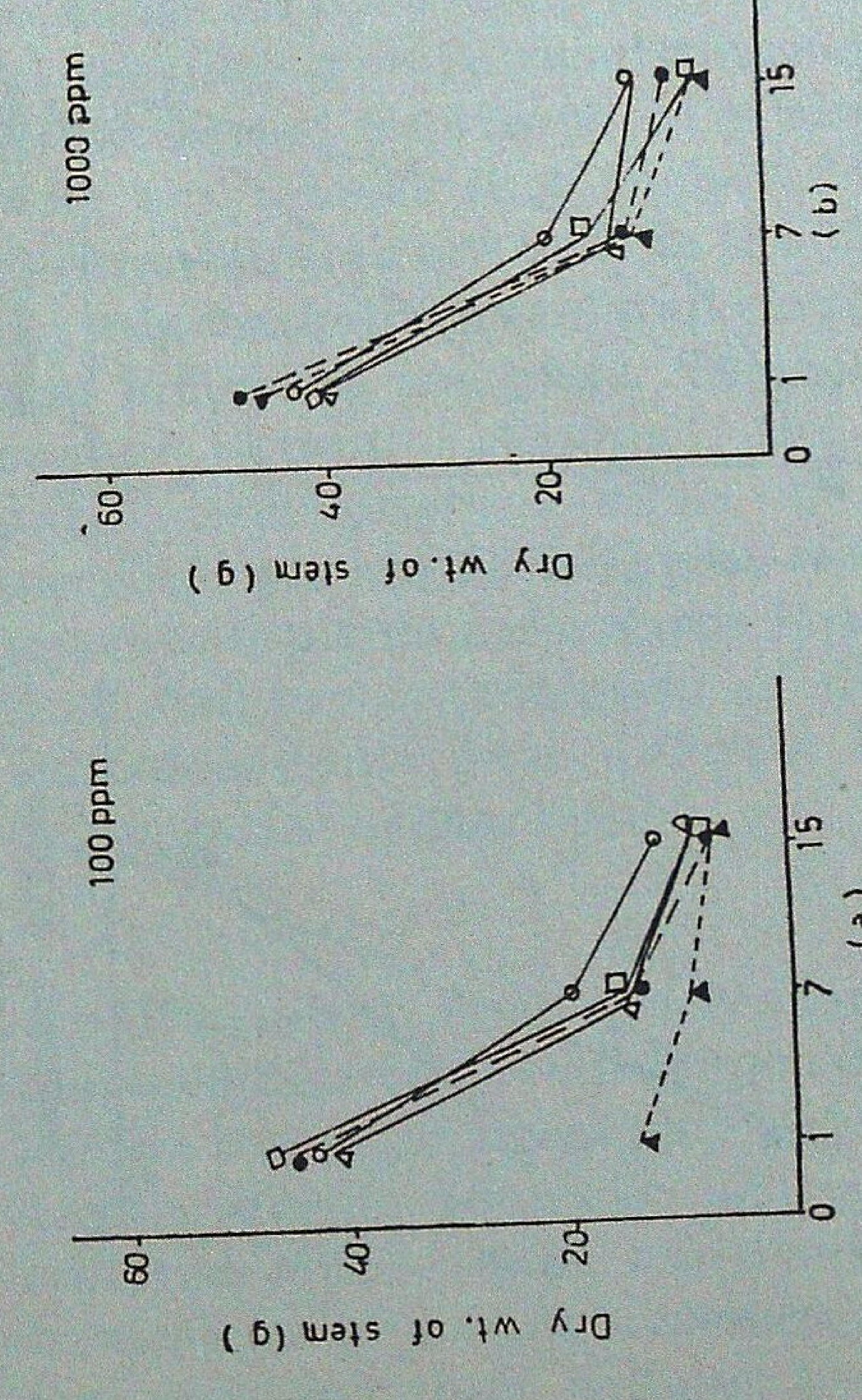


Fig. 8

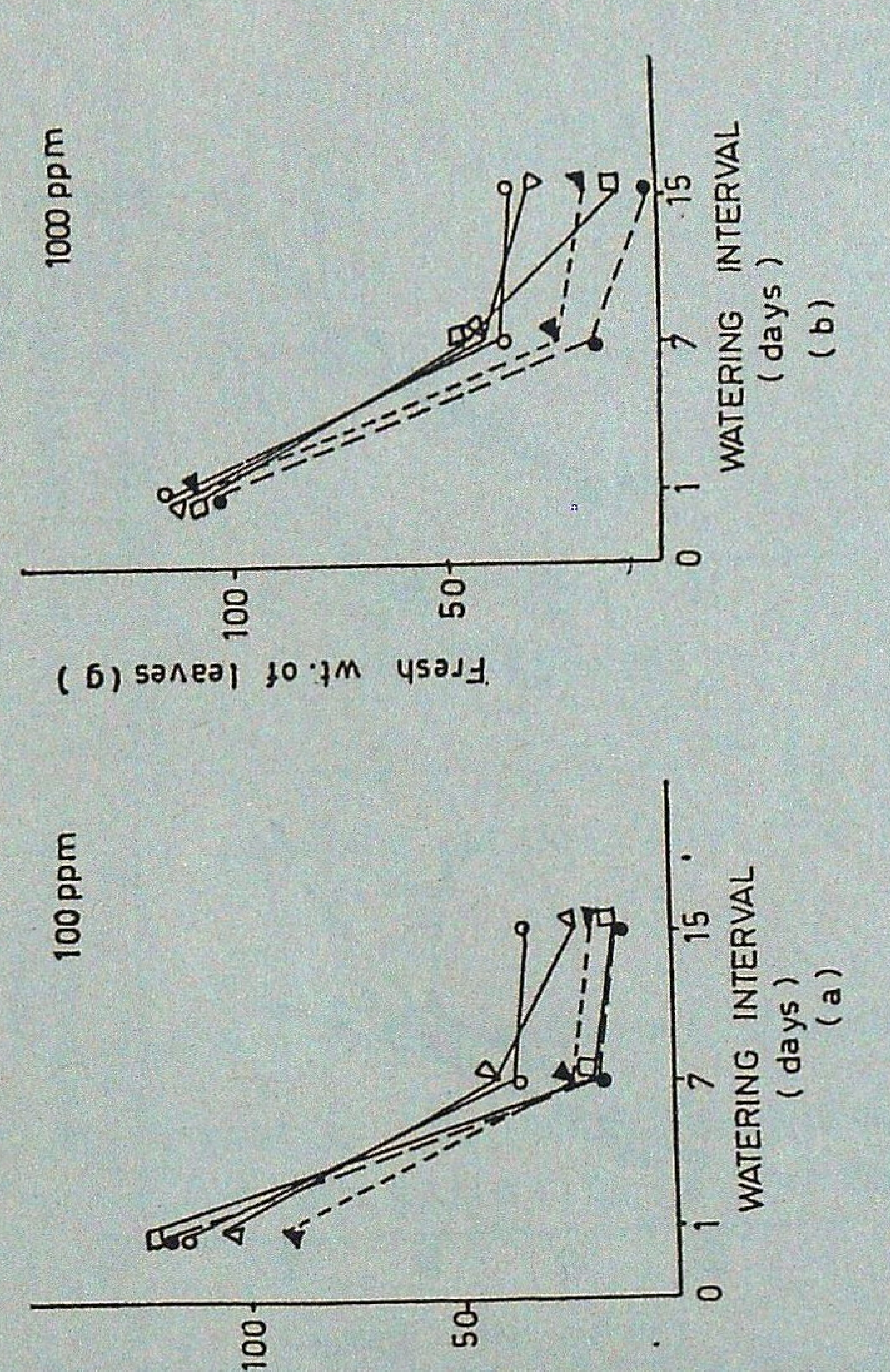
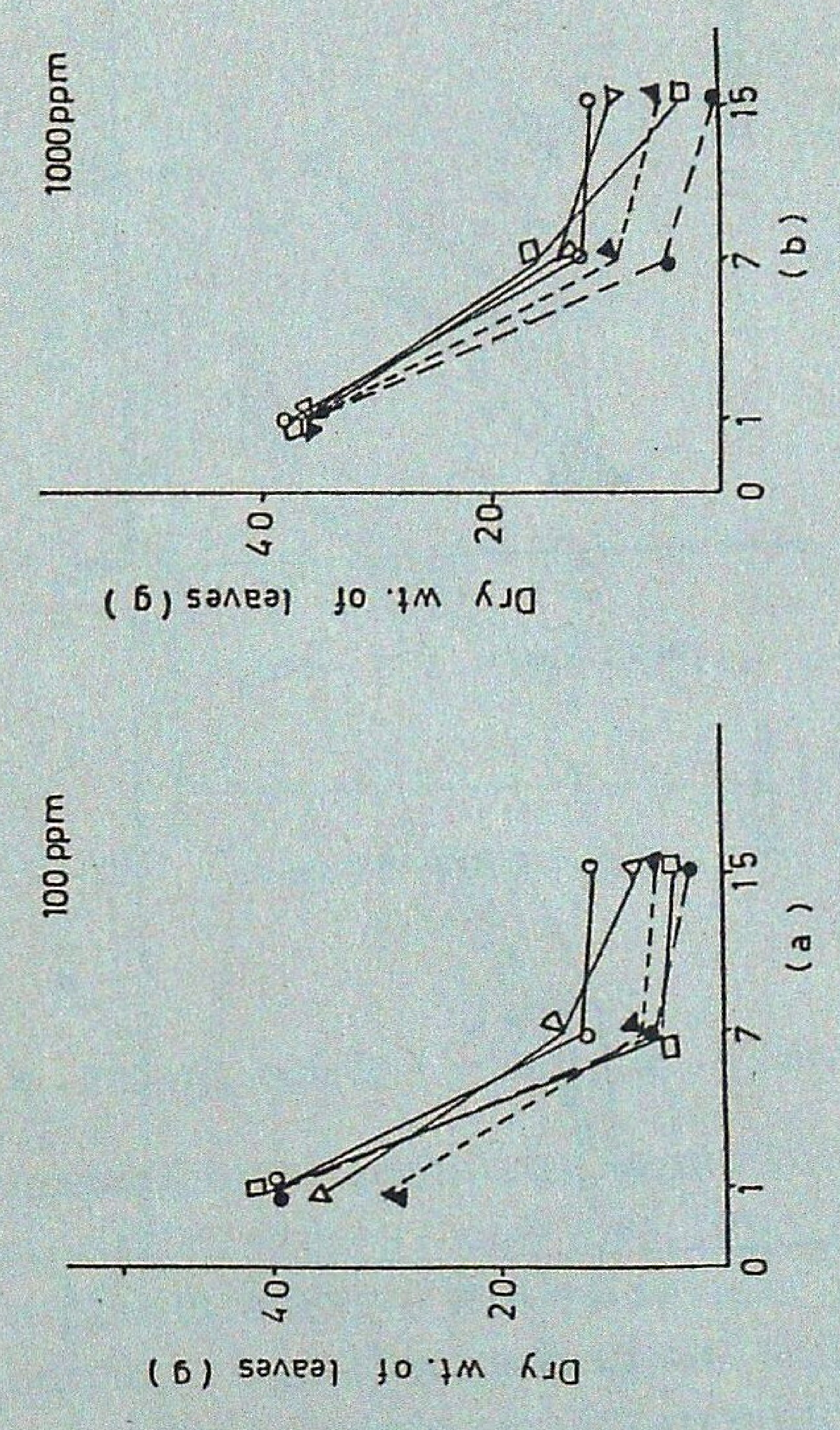


Fig. 9



O- Control; Δ - Sodium Benzoate; - Malic hydrazide; ● - Phenyl mercuric acetate; ▲ - Cyclocil

Fig. 10

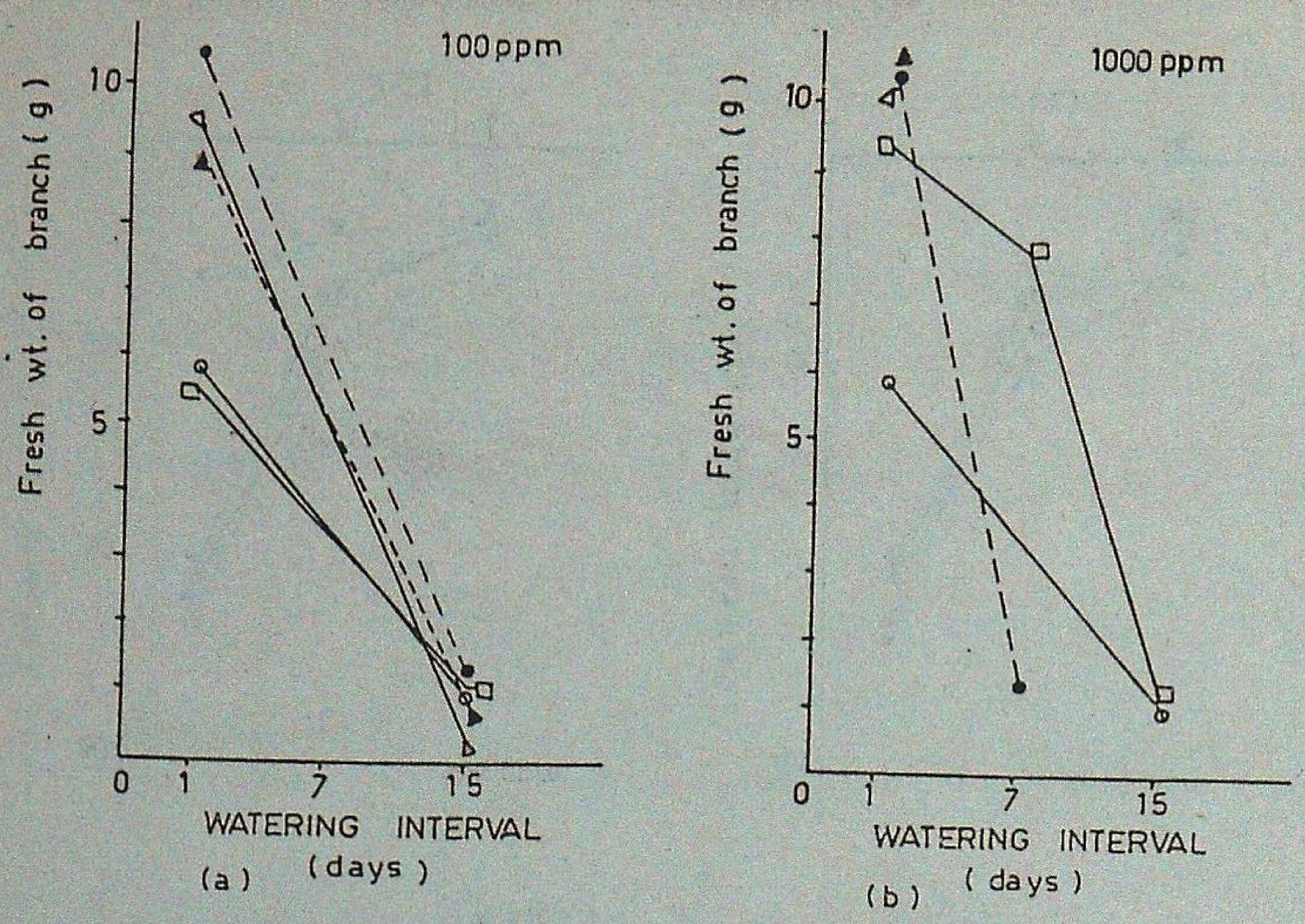


Fig. 11

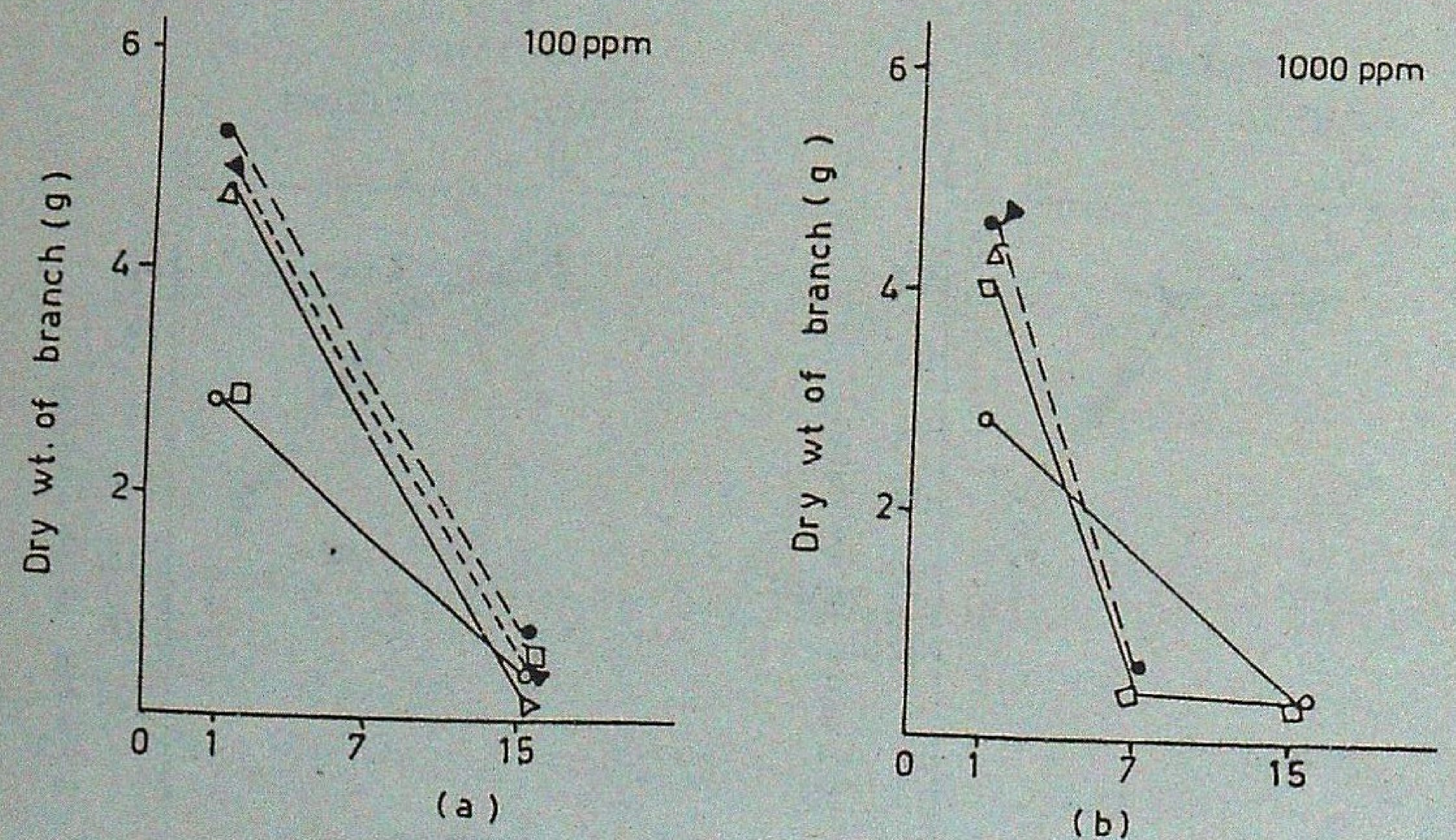


Fig. 12

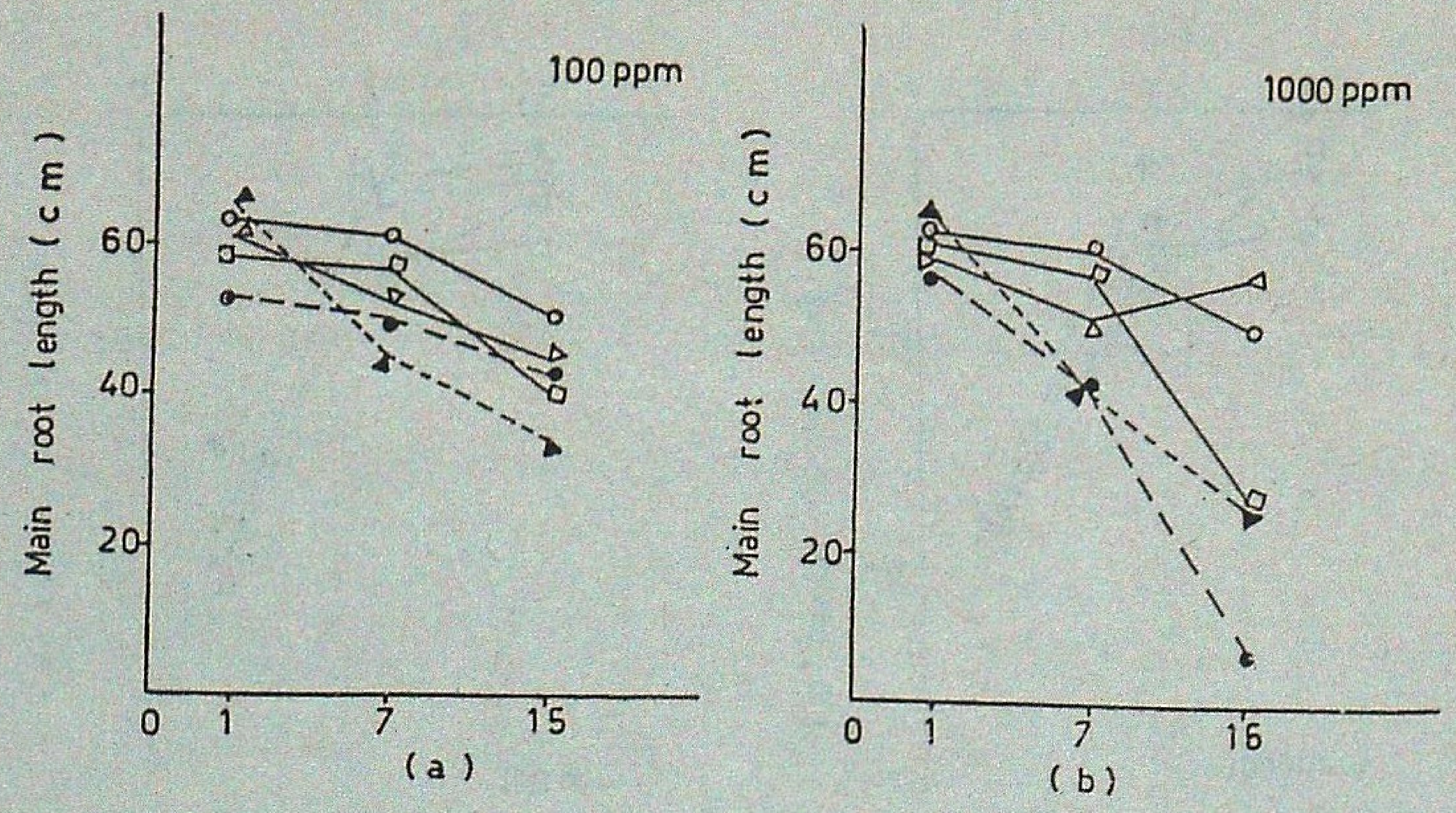
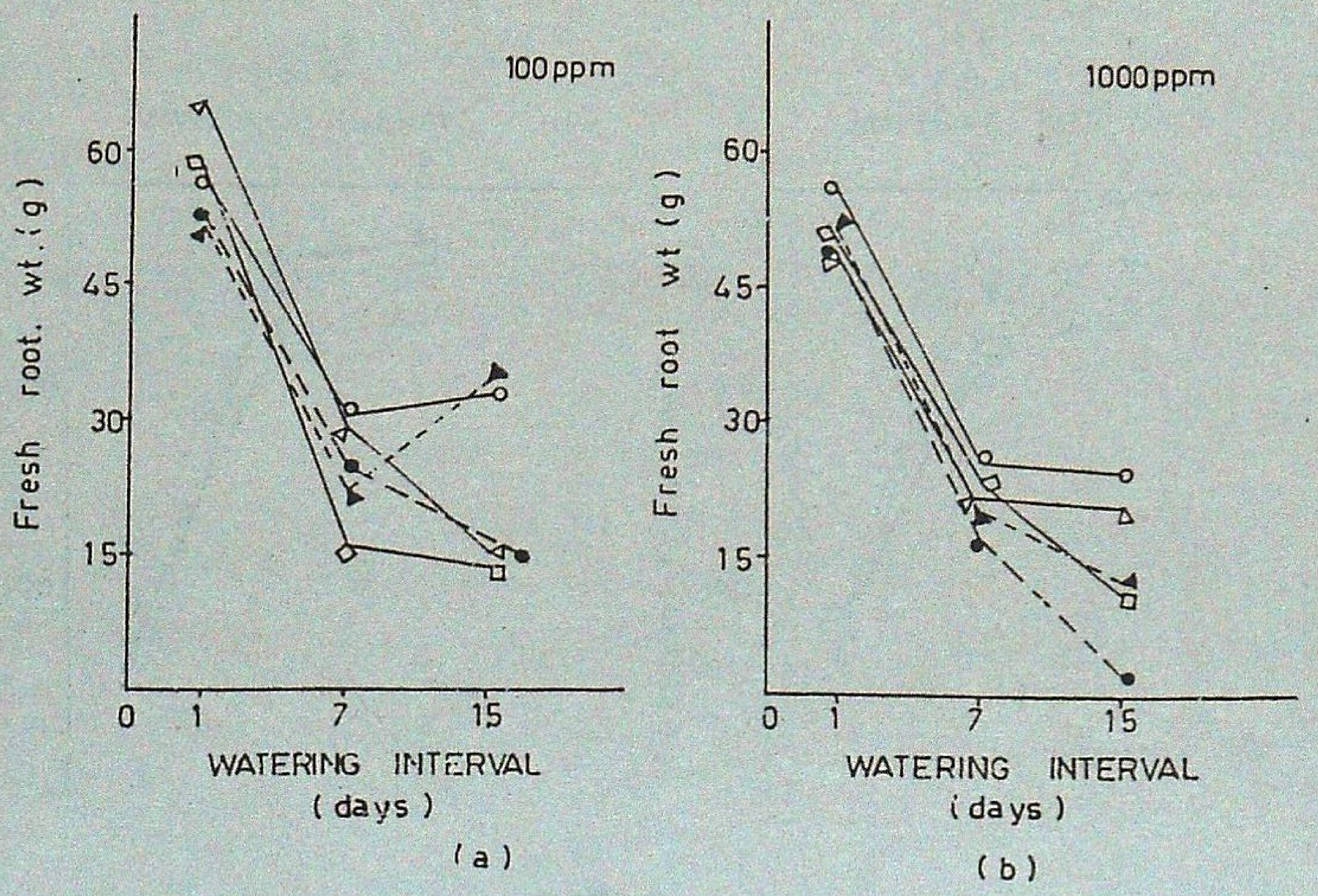
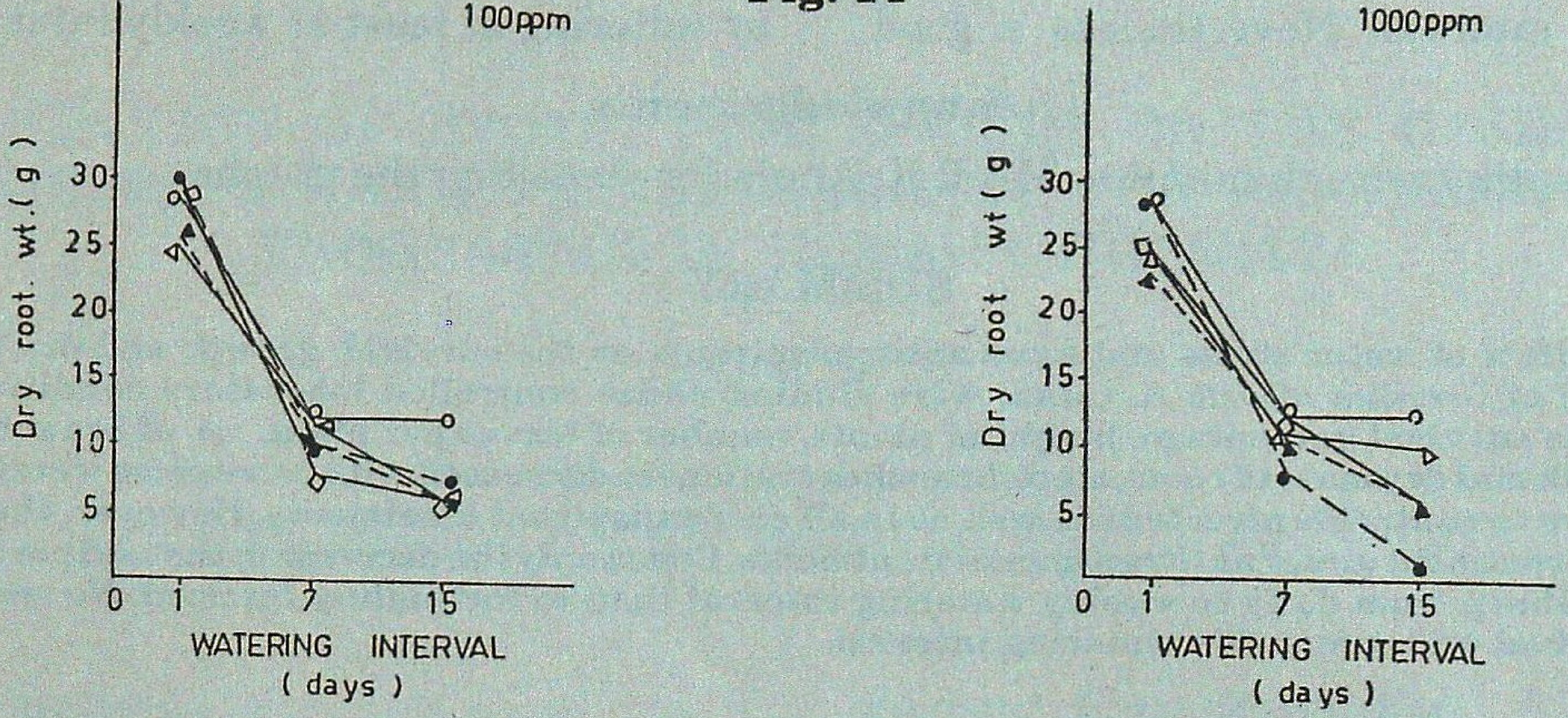


Fig. 13



O- Control; Δ - Sodium Benzoate; - Malic hydrazide; ● - Phenyl mercuric acetate; ▲ - Cyclocil

Fig. 14



(a) (b)

O- Control; Δ - Sodium Benzoate; □- Malic hydrazide; ● - Phenyl mercuric acetate; ▲ - Cyclocil

decrease of growth rate, stem elongation, leaf expansion and narrowing of stomatal aperture.

The results of these findings support many other findings that show a reduction of growth before the wilting point is reached (e.g. Handson and Hits, 1982; Van Volkenburgh and Boyer, 1985; Goubin and Kemp, 1992; Wang *et al.*, 1992; Nautiyal *et al.*, 1993). It is apparent that the relationship between water stress and growth is very complex, involving many physiological processes. Some investigators claim that the most serious effect of drought is a reduction of photosynthetic surface and of dry matter production. However, the reduction in net photosynthetic rate per unit of surface is also important.

The present study showed that the seedlings could sustain water stress upto a weeks time easily in both treated and untreated conditions but afterwards the treated seedlings with antitranspirants suffered more rapidly than the untreated ones, however, we have treated the seedling with antitranspirants keeping in view of their role in lowering the rate of transpiration to some extent and saving the plants from excess water loss, thus, helping the plants survive under severe drought condition. But the findings of this study showed the adverse results in which more seedlings survived under control condition i.e., seedlings grown without treatment than under treated conditions. It is also clear from the results that higher doses of antitranspirants are toxic to the plant. It not only checks the rate of transpiration but also influences the plant metabolism to some extent. Among the four antitranspirants the effect of phenyl mercuric acetate (1000 ppm) was more injurious to plants under stress. It indicates that similar concentration of different antitranspirants have different level of influence on the plant body.

The present study clearly showed that the seedlings of *Grevillea robusta* could sustain the water stress upto one to seven days watering interval; afterwards it suffered more under antitranspirants treatments and that too under higher concentration than without treatment. However, no chances of survival was observed in both the cases after 15 days watering interval. Nevertheless a good survival of the seedlings could be achieved by watering at least at weekly intervals.

Acknowledgements

The authors are thankful to Mr. R.K. Ahuja for stenciling the graphs.

SUMMARY

The effect of water stress and some antitranspirants on the survival, growth and dry matter production of *Grevillea robusta* A. Cunn. were studied under controlled laboratory conditions. In general, the survival percentage, height of plants, number of leaves per plant, no. of branches per plants, fresh and dry mass of roots, stem, branches and leaves decreased with increasing water stress irrespective to control (untreated) as well as in all antitranspirant treatments. However, the effect was more prominent under antitranspirant treatments. Commonly the decrease in the said parameter was more sharp from daily to weekly watering interval than to fortnightly interval. No seedlings could survival under monthly watering interval.

जल दबाव उत्स्वेदन विरोधियों के प्रति पादपों का प्रतिचारः *ग्रेविलिया रोबस्टा* ए० कनि० की वृद्धि और शुष्क पदार्थ उत्पादन में हुए परिवर्तन

एस० नौटियाल डी०एस० नेगी, एम० पाल व एस०पी० चौकियाल

सारांश

जल दबाव तथा कुल उत्स्वेदन विरोधियों का *ग्रेविलिया रोबस्टा* ए० कनि० की अतिजीविता, वृद्धि और शुष्क पदार्थ उत्पादन पर प्रभाव का अध्ययन नियन्त्रित प्रयोगशाला दशाओं में किया गया । सामान्यतः अतिजीविता प्रतिशत, पादपों की ऊँचाई, पत्तियों की प्रति पादप संख्या, शाखाओं की प्रति पादप संख्या, जड़ों, तने, शाखाओं और पत्तियों का शुष्क और ताजा पुंज सभी बिना नियामक का कोई विचार किए जल का दबाव बढ़ने के साथ और सभी उत्स्वेदन विरोधी उपचारों में घटे । तथापि, उत्स्वेदन विरोधी उपचारों में प्रभाव अधिक प्रमुख रहा । सामान्यतः इन परिमापों में हुई घटत पानी देने का अन्तराल पाक्षिक रखने की तुलना में दैनिक व साप्ताहिक रखने पर अधिक प्रखर निकली । पानी देने का अन्तर मासिक रखने पर कोई पौधा जीवित नहीं बच पाया ।

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SELECTION OF EXOTIC PINE SPECIES ON THE BASIS OF THEIR REPRODUCTIVE ADAPTABILITY FOR AFFORESTATION PROGRAMME IN KUMAUN HIMALAYA

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Introduction

Pinus is amongst the most hardy genera in conifers. It can grow on unfavourable mountain sites. It forms forests in rocky and exposed subtropical and cold regions where afforestation with other species is not possible. In Kumaun Himalaya *Pinus roxburghii* is the only indigenous pine which forms abundant forests. *P. wallichiana* is also an indigenous species but it is absent from this region or is found in small patches in inner dry zone. There is, therefore, much scope for introducing fast growing exotic *Pinus* species in outer regions of Kumaun. Large scale trials were, however, started in Kumaun in 1961-1962 (Lohani, 1968) at different altitudinal and latitudinal localities. The main centre in subtropical hill zone of Kumaun (U.P.) having large number of exotic species plantation chosen for this work is the Forest Research Centre at Kalika, situated near Ranikhet at 1750-1980 m altitude. The present study on reproductive biology of *Pinus* species were carried out for fourteen years i.e., from 1977 to 1990.

Out of sixty two *Pinus* species tried at the Forest Research Centre Kalika, highly successful ten exotic pines namely, *Pinus patula* Schiede and Deppe*, *P. greggii* Engelm*, *P. thunbergii* Parl*, *P. echinata* Mill*, *P. taeda* L.*, *P. elliottii* Engelm*, *P. pseudostrobus* Lindl., *P. densiflora* Sieb et Zucc., *P. pinaster* Ait, *P. canariensis* C. Smith were selected for the present study. Species selection for further detail study was made on the basis of high seed production and good seed quality so that their seed orchard can be established. Four *Pinus* species namely, *P. pinaster*, *P. canariensis*, *P. pseudostrobus*, *P. densiflora* were discarded because of poor cone, and seed production.

This investigation thus attempted to screen the successful species for male and female cone-set, seed-set, analysis of seed quality in which embryology was used to detect seed-sterility for species selection. An attempt was thus made for the first time in India in this direction, using embryological characters for seed analysis and ultimately for the selection of species. After elimination of four *Pinus* species, six *Pinus* species (with *) were studied in detail for their cone production and seed-set, empty seed formation, seed-sterility and seed-quality. Observations on these lines were recorded every year continuously for fourteen years. Due to their adjustment to the new environment exotic species have great variations in their reproductive biology in each year within and in between the species. Therefore, it is necessary to take more sampling and yearly observations to achieve good results.

Observation

Out of the six selected *Pinus* species, *P. elliottii* and *P. taeda* showed poorest male and female cone formation, seed-set and seed quality. Although *P. taeda* and *P. elliottii* performed well in their vegetative growth, but their seed-set was very poor in Kalika (Kumaun Himalaya). Lack or inadequate production of male flowers was the main reason for poor seed-set. Synchronization of female cone receptivity and pollen shedding is related to good seed-set, but it was observed in these two species that male flowers matured, dehisced and dropped before female strobili attained the stage of receptivity. A very few indehisced young male strobili were seen mostly on the lower branches of the trees during the study so there was very rare confidence between mature pollen and female flower receptivity (Sahai, 1989). Poor flowering (male and female cone formation) also depends on the positioning of the cones on the trees. Flowering was very good on that part of the tree which was on the sunny side. At Kalika pine tree were not growing in isolation but were growing in dense population of 30-40 trees of each species. There were poor production of male and female cones on the shady and dense side of the trees and thus resulting the poor seed-set.

The exotic tropical species studied are much affected considerably by climate. In India, they face many adverse climates and factors which are responsible for variations in production of cone and seed-set, seed quality and seed sterility. Climatic injury sometimes upset the balance between the embryo and endosperm development which is necessary for normal growth, survival and maturity of the seed (Gustafsson, 1962). Adverse climatic condition such as heavy hail storms, heavy snow, heavy rains and high temperature cause embryo death or abnormality in embryo and endosperm formation. These factors can cause injury in any stage i.e. early or late stages of embryo development. Survival of the embryo depends on the severity of the injury. The sensitivity to the adverse climate may reduce the seed-sterility for that year but if the large quantity of male strobili were on the top of the tree, there would be the possibility of selfing which increased sterility for particular species in particular years.

The species under trial at Kalika had narrow genetic basis. Empty seed formation and seed-sterility found in exotic pines is therefore sometimes genetic. Other main reasons which may be responsible for empty seed formation observed here are :

(i) The development of the ovule is at first fairly normal but incapable of being fertilized due to having deformed archegonia.

(ii) The ovule fails to develop fully because of injury to the cone or to the ovule itself.

Observations on empty seed formation in relation to embryo mortality showed that embryo mortality was also the major cause of empty seed. Empty seed can arise due to some other causes, such as lack of pollen as in *P. elliottii* and *P. taeda*, endosperms and embryo degeneration between pollination and fertilization stages.

In this study development of embryo and endosperm and its disturbances due to various causes were used to determine the degree of seed-sterility and empty seed formation for each species. It was proved that embryo mortality also caused an increase in empty seed formation. It was also proved that self-pollination occurred in these species resulting embryo mortality due to genetic causes. Some of the disturbances in embryology resulted from adverse climatic effects. These disturbances varied considerably in different localities, trees, species and genera in the species trials at Kalika.

The exotic species, however, grew under the same climatic condition. The ability of each species to survive in a particular climate may vary at species level. The adverse effect may disturb their embryo/endosperm and seed development which ultimately affects germination also.

Full or partial empty seeds were formed in species in variable quantity which enhanced seed-sterility. It was lowest in the species screened out namely *Pinus patula, P. greggii, P. thunbergii.*

Conclusion

On the basis of studies carried out from 1977 to 1990 it is concluded that amongst the six *Pinus* species, *P. patula* is the best species in respect of male and female cone-set, seed-set, low sterility and high seed quality. *Pinus greggii* and *P. thunbergii* are the second best species after *P. patula* growing in Kumaun Himalayas. These species remained steady in their male, female cone-set, seed-set, fertility and seed quality. Little variations in some years were exceptional and most probably affected due to the severity of climatic effects as mentioned earlier. These species may therefore be useful for seed orchard establishment, and afforestation work in the subtropical areas of Kumaun Himalaya.

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SUMMARY

Investigation for the selection of the fast growing exotic pine species were made on the basis of their reproductive adaptability in the subtropical region of Kumaun Himalaya. It was found that *Pinus patula* is the best performing species followed by *P. greggii* and *P. thunbergii*. Therefore these species can be used for seed orchard formation and afforestation programme in the dry exposed rocky areas of Kumaun Himalaya.

हिमालय के कुमाऊँ क्षेत्र में चीड़ की विदेशी प्रजातियों का वानिकी कार्यक्रम में उनकी प्रजनन अनुकूलनशीलता के आधार पर चयन

कनक सहाय

सारांश

हिमालय के कुमाऊँ कुपोषण प्रदेश में उनके प्रजनन अनुकूलनशीलता के आधार पर तेजी से विकसित होने वाले विदेशी चीड़ की प्रजातियों के चयन हेतु खोज की गयी । यह पाया गया कि *पाइनस पैटुला+*, *पाइनस ग्रिगाई* तथा *पाइनस थुम्बरजाई* अनुवर्ती वाली प्रजातियाँ हैं । ये प्रजातियाँ हिमालय के शुष्क दिखाई पड़ने वाले चट्टानी क्षेत्रों में बीज फलोद्यान निर्माण तथा वानिकी कार्यक्रम के लिए उपयोगी सिद्ध हो सकती हैं ।

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Snippets PROCEEDINGS

The proceedings of the following two conferences are available free of charge: *International Symposium on Public Participation and Environmental Conservation,* Tokyo, Japan, 7-9 November 1994, 114 pp, and *Growth and Yield of Tropical Forests,* Tokyo, Japan, 26 Sept-1 Oct 1994, 291 pp. All papers are in English. Contact: Prof. Yukichi Konohira, Tokyo University of Agriculture and Technology, 3-5-8 Saiwaicho, Fuchu, Tokyo 183, Japan.

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SOIL NUTRIENT CHANGES UNDER DIFFERENT AGES *EUCALYPTUS* MONOCULTURES

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Introduction

Single tree species plantation or monoculture of trees has now become widely accepted practice. It has been mainly inspired by agricultural practices where human intervention is considerable. The wide gaps between demand and supply of timber, fuel and fodder has lead to the monocultures in which human intervention has a strong role to play. However, the nutrient management in monocultures is either negligible or based on the assumption of infinite capacity of soil to maintain the stand and replenish the enormous nutrient export from the land after energy rotation. This is not so as amply born out by the recent findings on soil depletion and unfavourable nutrient changes in intensively managed tree monocultures. The documented reports on *Eucalyptus* with respect to nutrient changes bring this fact to light. Proper understanding of soil : plant relationship can put this view on a rational basis and lead to more scientific approach to management of monoculture of tree species. It is extremely important to develop forest soil fertility evaluation programme in order to assess soil fertility, nutrient depletion rate due to the plantation of different species.

The present paper is an attempt to provide the idea about the nutrient depletion or gain in the soil due to *Eucalyptus* monocultures of different ages in comparison to natural forest.

Materials and Methods

This study was conducted in Barkot Forest Range of West Dehra Dun Forest Division. The area has a tropical monsoon climate. The temperature ranges from 4°C in December to 35°C in May. The mean summer and winter temperatures are respectively 25°C and 13.3°C. The soils are alluvium received from Shiwaliks and Himalayas.

Pure *Eucalyptus* plantations of 5, 10, 15 and 20 years were selected for study along with adjoining sal natural stand of *Shorea robusta*. Nine sites under each plantation were selected and soil samples from each locations were collected through auger boring from 0-15, 15-30, 30-60, 60-90, 90-120 and 120-180 cm depths. Soil samples were air dried and processed as per the standard procedures described by Jackson (1967). Physical and chemical properties determined by the standard procedures described by Black (1965) and Piper (1966).

Results and Discussion

Analytical results of physico-chemical

attributes of soils under different monocultures and natural sal are given in Table 1. Soil under natural sal was considered as the benchmark soil to compare the magnitude of change, in soil properties.

Results show pronounced migration of clay particles down the soil profile in 5 years old monoculture than natural sal. Organic carbon, total and available nitrogen, available phosphorus, potassium, content were higher in 5 years monoculture than natural sal. This trend could be due to enhanced micro-biological activities in freshly exposed sites. It has been observed that after clearing of an area for reforestation and due to exposure the availability of sun light, soil moisture and temperature increases and promotes rapid decomposition of organic matter, hence available nutrients and humus rise during this period. A five year monitoring of *Eucalyptus* plantation showed variable increase in organic carbon and soil phosphorus (Kushalappa, 1985). Jha and Pandey (1984) have also reported that *Eucalyptus* monoculture of fairly young age has shown higher accumulation of organic matter in comparison to sal monoculture. Soils under 10 years old *Eucalyptus* monoculture were less acidic compared to natural sal. Migration of finer particles down the profile were clearly observed only upto 120 cm depth (Fig. 1). Enrichment of organic carbon, total N, P, K, available N, P and K, exchangeable Ca^{++} and K^{+} were less in the soils under 10 years old *Eucalyptus* monoculture than natural sal. All the nutrients except total and available K were found less in the soils under 10 years old monoculture than 5 years old monoculture. This may be because of higher uptake of nutrients by well develop vegetation in comparison to 5 years old *Eucalyptus* as well as low residual nutrient pool from clearing. Migration of finer particle down the soil profile was clearly observed in the soils under 15 years old *Eucalyptus* monoculture but this migration was less marked as compared to 10 yrs. old plantations (Fig. 1). Clearfelling and reforestation enhancing the pedogenetic process. After in the early duration of time i.e. under 5 year old plantation, migration of finer particle starts but it was pronounced under 10 year old plantation. After that this process became slower under 15 yrs old plantation and upto a certain age i.e. 20 years in this case these processes became stabilised and rapid migration checked especially in the upper layers. Soils were less acidic in reaction below 15 cm depth under 15 years old monoculture in comparison to not only with natural sal but 5 and 10 years old monocultures also. Soils under 20 years old monoculture were also acidic. In general organic carbon, total P, available K, exchangeable Ca, were less in all depths in the soils under 20 years old monocultures while for total N, K and available N and P the trend was reversed. Nutrient status of soil under 5, 10 and 15 years old *Eucalyptus* monoculture were generally in decreasing order. Thus, it is observed that soil enriches due to rapid decomposition of litter after clearing. The higher fertility condition is not maintained because of absence of further leaf fall. In addition to this, new crops also uptakes large amount of nutrients. The depression in the soil nutrient status can be seen even in 20 years old monoculture.

Different soil analysis under 5, 10, 15 and 20 years old *Eucalyptus* monocultures enable us to compare the soil attributes under *Eucalyptus* monoculture and natural sal. It was also tested whether these monocultures of different duration has any effect on soil attributes at different depths. The observations has been made at 0-30,

Table 1

Physico-chemical attributes of soil under natural Sal and Eucalyptus monocultures of different ages

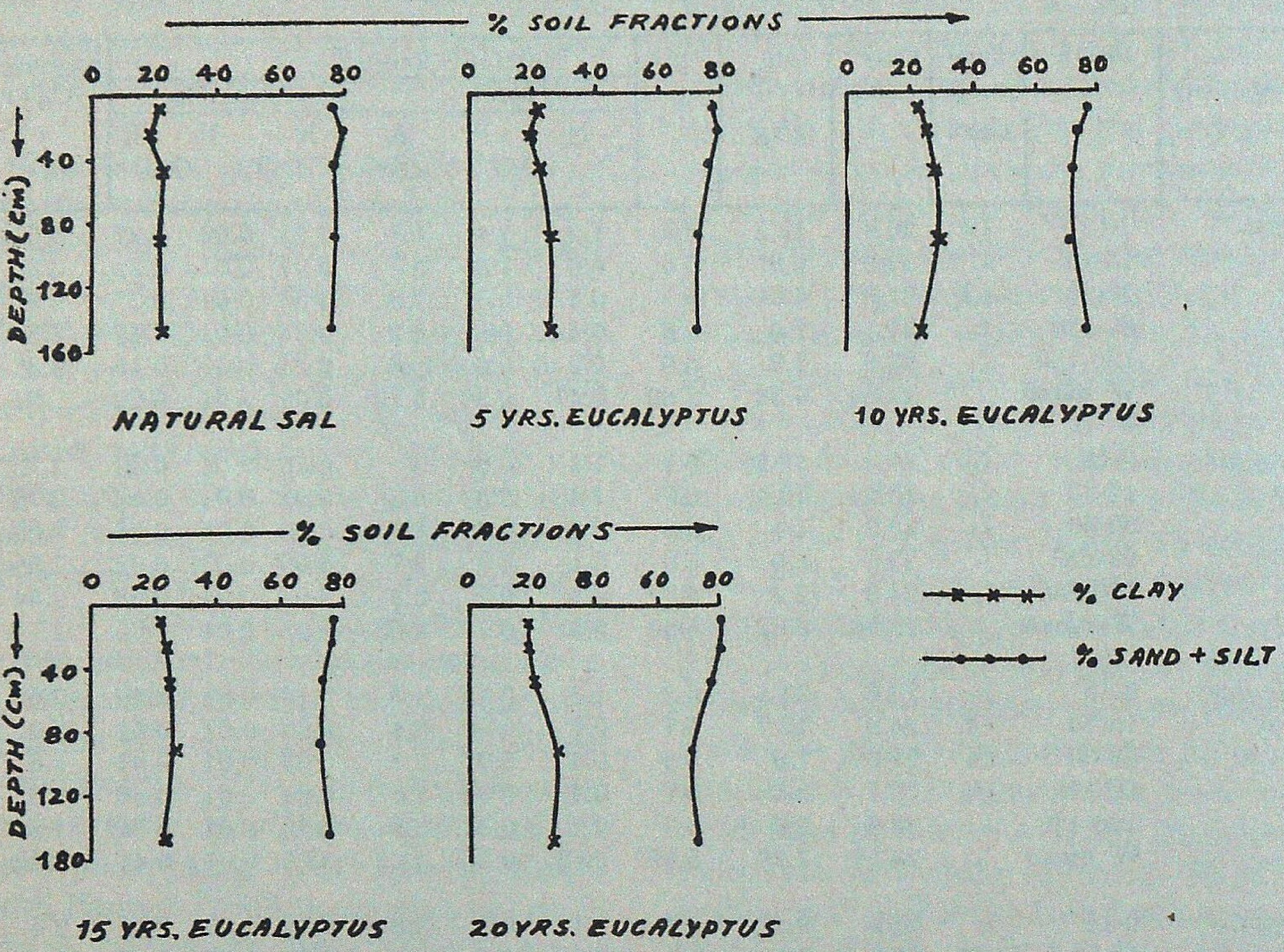
Species	Depth (cm)	Texture class	Clay (%)	Org. C g/kg	pH	Nutrient Content						Exchangeable	
						Total			Available			Ca++	K+
						N	P (P_2O_5)	K (K_2O)	N	P (P_2O_5)	K (K_2O)	(%) (m.e.)	(%)
Natural Sal	0-15	Cl	20.8	18.2	6.1	1.2	1.1	6.8	0.11	0.02	0.27	6.5	0.32
	15-30	L	19.8	8.8	6.0	0.6	1.3	5.7	0.07	0.01	0.22	3.8	0.32
	30-60	Cl	21.6	4.0	5.7	0.5	0.8	7.5	0.06	0.01	0.2	2.9	0.40
	60-120	L	21.1	2.5	5.6	0.4	0.8	5.2	0.04	0.01	0.18	2.5	0.30
	120-180	L	22.6	1.9	5.6	0.3	0.6	5.6	0.04	0.01	0.19	2.3	0.26
	W. mean		21.55	4.38	5.69	0.47	0.80	5.89	0.05	0.01	0.20	2.94	0.31
Eucalyptus 5 year	0-15	L	21.3	18.2	6.1	1.2	0.9	3	0.10	0.04	0.39	2.72	0.89
	15-30	L	20.2	10.4	6.0	1.0	0.8	3.8	0.02	0.04	0.31	2.76	0.88
	30-60	L	22.2	7.4	6.0	0.6	0.7	3.6	0.05	0.05	0.35	2.68	0.91
	60-120	L	25.3	5.0	5.0	0.4	0.7	3.7	0.05	0.03	0.33	2.68	0.83
	120-180	L	24.8	2.2	5.7	0.3	0.7	3.4	0.04	0.04	0.38	2.84	0.75
	W. mean		23.96	6.02	5.58	0.52	0.73	3.53	0.05	0.04	0.35	2.74	0.83
Eucalyptus 10 year	0-15	L	22.6	13.5	6.3	1.2	0.19	4.1	0.10	0.01	0.50	2.6	0.26
	15-30	Cl	24.9	12.7	5.7	0.7	0.60	3.4	0.06	0.01	0.51	2.0	0.28
	30-60	Cl	27.0	1.9	5.8	0.4	0.97	3.1	0.05	0.01	0.47	1.6	0.28
	60-120	Cl	28.7	2.6	5.7	0.4	0.05	3.6	0.04	0.01	0.39	1.6	0.26
	120-180	L	23.6	2.6	6.0	0.2	0.04	3.8	0.03	0.01	0.36	1.6	0.28
	W. mean		24.51	4.23	5.87	0.43	0.26	3.61	0.05	0.01	0.41	1.72	0.27
Eucalyptus 15 years	0-15	L	21.4	9.4	6.1	1.1	0.3	3.6	0.12	0.07	0.32	2.4	0.32
	15-30	Cl	22.6	5.4	6.1	0.6	0.3	3.7	0.07	0.07	0.13	1.8	0.26
	30-60	Cl	25.4	2.6	5.9	0.4	0.5	5.2	0.05	0.06	0.14	1.6	0.70
	60-120	L	25.9	1.4	6.0	0.3	0.3	4.2	0.04	0.06	0.12	1.6	0.23
	210-180	Cl	22.8	1.2	6.0	0.2	0.2	4.4	0.03	0.06	0.10	1.7	0.22
	W. mean		24.13	2.53	6.0	0.38	0.30	4.34	0.05	0.06	0.13	1.72	0.32
Eucalyptus 20 years	0-15	L	19.5	14.9	6.1	1.2	0.5	7.7	0.12	0.07	0.16	4.4	0.44
	15-30	L	19.5	6.4	5.8	0.7	0.5	8.2	0.09	0.04	0.15	2.8	0.41
	30-60	L	21.0	3.6	5.8	0.5	0.5	7.8	0.08	0.05	0.14	2.6	0.33
	60-120	L	28.8	2.0	5.8	0.4	0.4	8.8	0.06	0.06	0.10	2.5	0.29
	120-180	L	27.4	2.2	5.7	0.4	0.3	6.5	0.06	0.03	0.14	2.8	0.34
	W. mean		25.48	3.78	5.79	0.51	0.40	7.73	0.07	0.05	0.13	2.80	0.39

Cl = Clay loam, L = Loam

30-60 and 60-120 cm depths. These depths have been described as top, middle and lower layers with regard to rooting activities. Data are shown in Table 2.

The observations on the total N content in different depths under 5 years old plantation showed a gain of 20-22% in upper and middle layer and no change in lower layer. There was a decrease in total potassium level of nearly half in top and middle layer and about 29% in lower layer. The available phosphorus under 5 years old plantation showed a phosphorus build up of 1.6 time in top, 4 time in middle and 2 time in lower layer. The soil phosphorus changes

Fig. 1



Rate of pedogenesis under *Eucalyptus* plantations of different ages and natural forest

Table 2

Loss and gain in soil attributes down the profile under different monoculture plantations in comparison to Natural sal

Species	Depth (cm)	Clay	D.C.	Total nurtrients			Available nutrients		
				N	P	K	N	P	K
Eucalyptus	30	2	6	22	-33	-45	0	167	46
5 years	60	-2	85	20	-13	-52	-17	400	75
	120	22	100	0	-13	-29	25	200	83
Eucalyptus	30	28	-3	0	-8	-40	-11	-33	108
10 years	60	32	-55	-20	13	-59	-17	0	135
	120	29	4	0	-38	-31	0	0	116
Eucalyptus	30	20	-45	-11	-75	-42	-11	367	-8
15 years	60	23	-35	-20	-38	-31	-17	500	-30
	120	35	-44	-25	-63	-19	0	500	-33
Eucalyptus	30	7	-21	20	-42	27	11	366	-37
20 years	60	2	-10	20	-38	4	33	300	-30
	120	51	-20	20	-50	69	50	400	-44

are at variance with others primarily due to microbial link with its content, species requirements and appropriateness of phosphorus extraction method. There was a gain in available K of 45% in top, 75% in middle and 83% in lower layers. Yadav *et al.* (1973) have also reported slight decrease in Hcl soluble K_2O and P_2O_5 and increase in the availability of K_2O in the soils during 5 years period under *Eucalyptus* monoculture in comparison to natural sal. There was a general gain in clay content in top and lower layer while a marginal loss of 2% in middle layer. Downward movement in finer particles in the soils under 5 years old monoculture is in conformity with the findings of Yadav *et al.* (1973).

In the soils under 10 years old *Eucalyptus* monoculture, there was no change in the contents of total nitrogen in upper and lower layer whereas contents decreased by 20% in middle layer. Total phosphorus showed accumulation of 8-12% in top, and middle and loss of about 37% in lower layer. There was a loss of total potassium about 40% from the top, 58% from the middle and 30% from the lower layer. Available nitrogen content under 10 years old monoculture showed loss of 11% from top, 17% from middle and lower layer remain unchanged. Available phosphorus in top layer showed loss of 33% and middle and lower layer showed no change. There was a gain in available potassium content of 1.08 times in top, 1.35 times in middle and 1.16 times in lower layer.

Under 15 years old monocultures, there was loss of soil nitrogen by 11% in top and 20-25% from middle and lower layers. The changes in the soil nitrogen show an increase in the content in the short term followed by a fall when the longer duration plantation were tested, as in the case of organic carbon. A substantial loss of total phosphorus 75% from top, 37% from middle and 62% from lower layer in 15 years plantation was observed. Loss of 42% from top, 30% from middle and 19% from lower was observed in total potassium contents. Available nitrogen contents followed the same trend as under 10 years old plantation. The available phosphorus content under 15 years old monoculture showed a build up of 3.66 times in top, 5 times in middle and lower layers. Nutrient removal under a short rotation plantation system was much greater than that under a native forest. Nutrient removal for short rotation *Eucalyptus* plantation is dependent upon the species, and the harvesting regime (Wise and Pitman, 1981).

Organic carbon content under 20 years old *Eucalyptus* monoculture plantation showed a little recovery in comparison to 15 years old plantation but ultimately showed loss of 21% in top, 10% in middle and 20% in lower layer in comparison to natural sal. Total nitrogen content was same as under natural sal. There was loss in total P and available K content in all depths while gain in total K, available N and P and clay content in all depths in comparison to natural sal. Gain in clay content, total K, available N and depletion in organic carbon, total P and available K in the soils of 17 years old *Eucalyptus* monoculture in comparison to natural sal was reported by Jha and Pandey (1984). It is evident from the data that soils under 20 years old plantation were not so much depleted in nutrient in comparison to 10 and 15 years old plantation. Hence it could be stated that soil approaching 20 years old of *Eucalyptus* plantation starts maintaining its fertility because of litter accumulation on forest floor and consequent mineralisation process yielding nutrient over and above demands of the root surface.

SUMMARY

Soil nutrient changes were studied under 5, 10, 15 and 20 years old *Eucalyptus* monocultures, in comparison to natural sal forest. Soil nutrient depletion under 10 and 15 years old monocultures were higher than 5 and 20 years old monocultures, in comparison to natural sal. Soil profile distribution of attributes showed gain in clay content and available P and loss in total K and P in all monocultures as compared to natural sal. The soil under 5 year and 20 year monocultures were less depleted because of faster mineralisation of residual organic matter in 5 years old monoculture and a gradation of soil nutrients as the monoculture aged as in 20 years old monoculture.

युकेलिप्टस एकजातिसंवर्धन के अधीन विभिन्न उम्रों पर मृदा पोष्याहारों में परिवर्तन

एम०एन० झा, बी०एम० डिमरी व एम०के० गुप्त

सारांश

प्राकृतिक शाल वनों की तुलना में 5, 10, 15 और 20 वर्षीय *युकेलिप्टस* एकजातिसंवर्धनों में हुए मृदा पोष्याहारों के परिवर्तन का अध्ययन किया गया । 5 और 20 वर्षीय एकजातिसंवर्धन की तुलना में 10 और 15 वर्षीय एकजातिसंवर्धन में पोष्याहारों का निकलना प्राकृतिक शाल वन के मुकाबले में अधिक रहा । मृदा पाश्र्वचित्र में उसके अंगों के वितरण में चिकनी मिट्टी तथा उपलब्ध फास्फोरस में लाभ तथा पोटाशियम और फास्फोरस में कमी प्राकृतिक शाल की तुलना में सभी एकजातिसंवर्धनों में देखी गई । 5 और 20 वर्षीय संवर्धनों में पोष्याहार कम घटे हुए पाए गए क्योंकि 5 वर्षीय एकजातिसंवर्धन में अवशिष्ट जैव तत्वों का खनिजायन और एकजातिसंवर्धन की उम्र बढ़ने पर मृदा पोष्याहारों का अश्रेणीकरण जैसा 20 वर्षीय एकजातिसंवर्धन में हुआ, तेज गति से होता है ।

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MICROPROPAGATION OF ELITE *EUCALYPTUS* TYPES THROUGH SHOOT TIP CULTURE

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Introduction

The *Eucalyptus* plantations were mostly raised through seeds of unknown origin which exhibited a considerable variability for morphological and growth characters. It is mostly attributed to the genetic segregations owing to heterozygosity of the seed plants. Frequency of clear boled saleable trees in the populations was only 20.30% in five year rotation, remaining trees may be either slow growing laggards or affected due to biotic and abiotic stresses (Jambhale *et al.,* 1993). Identification of superior genotypes and their clonal propagation can result in large genetic gains in both yield and quality of manmade plantations (Leaky, 1986). Yield improvement using vegetative propagules to the extent of 64 m^3 $ha^{-1}y^{-1}$ has been achieved with *Eucalyptus grandis* on six year rotation in Brazil (Zobel and Ikemori, 1983). Gurumurti and Bhandari (1987) have shown that there is scope to triple the yield of *Eucalyptus* by multiplication through vegetative propagules. Tissue culture propagation methods have also been developed in *Eucalyptus* (Sita and Vaidyanathan, 1979; Gupta *et al.,* 1981).

Nilgiri Mahasangh, Nasik, Maharashtra has selected 10 elite *Eucalyptus tereticornis* trees in 6 year old plantation at Rethare BK., Distt. Sangli (Maharashtra). With a view to ascertain genetic superiority of the elite trees it was decided to micropropagate the elite trees by means of shoot tip culture, the results of tissue culture propagation are presented in this paper.

Materials and Methods

Three months old coppice shoots produced after cutting six year old eight selected *Eucalyptus tereticornis* trees at Rethare BK., Distt. Sangli were brought to Rahuri during September 1992. Two to three node cuttings, 3 to 4 mm in diameter with half cut leaves, treating basal ends with IBA (4000 ppm) were planted in the greenhouse in 1 to 2 mm sand.

Newly sprouted shoots of the cuttings in the greenhouse were used for *in-vitro* shoot tip culture. Shoot tips 1 to 2 cm long were surface sterilized in 0.1% (W/V) $HgCl_2$ for 10 m and then washed three times with sterile distilled water. The shoot tips cut into 5 to 10 mm length were cultured in 20 x 150 mm culture tubes containing Murashige and Skoog (MS) medium (Murashige and Skoog, 1962) with 3% sucrose, 0.7% agar (Bacteriological grade), 1 g/l BAP and 0.1 mg/l IAA (MS-1). Fifteen to twenty shoots per tree were cultured. The established shoot tip explants were transferred in 150 ml conical flasks containing 40 ml of medium MS + 0.5 mg/l BAP + 0.1 mg/l IAA + 0.1 mg/l Kinetin + 0.1 mg/l Biotin (MS-2) (SC-1). After 60 days of SC-1 the proliferated shoots of 4-5 cm length were cut and used for *in-vivo* rooting. Cultures were then transferred in 150 ml conical flasks containing 40 ml of MS-2 medium. After harvesting of long shoots with bent scizzor some of the SC-1 flasks were also incubated as such without transfer or sub-culture. All the cultures maintained under an 8 h photoperiod with 700 Lux light intensity from cool white fluorescent tubes and at 25±3°C.

In-vitro rooting : The shoots of 6 to 8 cm length were dipped in sterile half strength MS liquid medium containing 4 mg/1 IBA for 72 h in dark and subsequently transferred on half strength MS medium containing 4 g/l activated charcoal.

In-vivo rooting : The basal ends of shoots were treated with 4000 ppm IBA and planted in polybags of 7 x 5 cm size containing 1-2 mm sand placed in greenhouse at about 85 to 90% humidity and 30±2°C temperature. The rooted seedlings were transferred to polybags of 25 x 11.5 cm size containing 1:1:1 soil, sand and compost and hardened at 70-80% humidity at 30-35°C.

Results and Discussion

Eucalyptus selections exhibited differential response for the *in-vitro* establishment, maximum being in SRY-10 (90%) and minimum in SRY-7 (13.1%) (Table 1). The low responding types viz. SRY-7, SRY-13, SRY-17, SRY-19 relatively showed more browing of tissues than that in types with better establishment. The established shoot tips in a month exhibited axillary bud proliferation.

Table 1

In-vitro response of eight selection in Eucalyptus tereticornis

Selection No.	Establishment of shoot tips (%)	No. of shoots/ explant in flask 60 days after SC$_1$	No.of Shoots flask after 30 days of SC$_2$	No. of shoots/ shoots/flask after 30 days of harvesting shoots in SC$_1$ flasks (Ratoon)
SRY-2	55.5	43.6 (13.2)	16.0 (5.4)	46.3 (5.8)
SRY-6	75.0	68.0 (18.2)	30.6 (6.3)	64.6 (12.3)
SRY-7	13.1	29.9 (6.8)	12.4 (6.2)	26.7 (3.7)
SRY-10	90.0	75.4 (25.6)	38.6 (11.6)	68.2 (17.8)
SRY-13	20.0	31.6 (10.2)	17.4 (3.2)	27.6 (3.2)
SRY-16	40.0	44.2 (11.3)	12.8 (2.8)	32.2 (4.6)
SRY-17	20.0	31.8 (9.8)	6.4 (2.0)	20.6 (3.3)
SRY-19	20.0	25.2 (10.2)	9.6 (1.9)	1.7 (3.6)

Figures in parenthesis denote number of shoots cut for induction of rooting.

Table 2
In-vitro and in-vivo rooting response of micropropagated Eucalyptus tereticornis plantlets

Selection No.	*In-vitro*					*In-vivo*			
	No. of shoots cultured	No. of shoots rooted	Rooting (%)	Average no. of roots/ plantlets	Survival in hardening (%)	No. of shoots planted in green-house	No. of shoots survived and rooted	Survival and rooting (%)	Average no. of roots/ plantlet in 30 days
SRY-2	40	28	70.0	2.4	65.0	20	13	65.0	4.5
SRY-6	32	17	53.1	3.2	72.0	25	18	90.0	5.2
SRY-7	25	13	52.0	2.5	86.0	10	7	70.0	4.3
SRY-10	80	54	67.5	3.4	80.0	90	73	81.1	5.6
SRY-13	15	6	40.0	3.0	72.0	12	7	58.3	3.6
SRY-16	20	12	60.0	2.4	70.0	20	15	75.0	2.8
SRY-17	10	75	50.0	3.6	69.0	15	11	73.3	3.6
SRY-19	15	7	46.6	2.1	65.0	10	60	60.0	4.3

Profused shoot proliferation was evident on sub-culture after 30 days (SC-1) in all the types. Counting all the shoots proliferated after 60 days of SC-1 revealed production of 25.2 to 75.4 shoots/explant out of which 6.8 to 25.6 shoots per explant achieved growth of 6 to 8 cm which were cut for rooting. Genotypes SRY-10 (25.6), SRY-6 (18.2) and SRY-2 (13.2) produced maximum number of plantlets suitable for rooting *in-vitro* and *in-vivo*. In subsequent sub-cultures number of plantlets/flask suitable for harvesting for rooting were reduced after one month (2 to 11.6) (Table 1). The cultures ratooned without sub-culturing produced 3.2 to 17.8 shoots/flask after one month of cutting of long shoots. Maximum shoots were produced by SRY-10 after one month of SC-1 (11.6) and or ratoon (17.8). The frequency of desired shoots was relatively more in ratooned cultures than that of subcultured one. Gupta and Mascarenhas (1987) reported 6 to 15 shoots/explant in 30 days of sub-culture in different *Eucalyptus* species.

In general, the selections having better establishment had better shoot proliferation in subsequent sub-cultures also. The differential response may be attributed to the genotypic difference of the selections.

Rooting of plantlets *in-vitro* ranged from 40-70% in 8 weeks with 2.1 to 3.4 roots/shoot (Table 2). The rooted plantlets had about 70% survival in hardening. The *in-vivo* rooting was observed in 15 days after planting in sand. Success in simultaneous *in-vivo* rooting and hardening was 70 to 90%. *In-vivo* rooting and hardening seems to be effective, convenient and economical for micropropagation of *Eucalyptus*.

SUMMARY

The results of tissue culture propagation of elite trees of *Eucalyptus tereticornis* are presented in this paper to ascertain the genetic superiority.

प्ररोह-नोक संवर्धन द्वारा श्रेष्ठ *युकेलिप्टस* प्ररूपों का अणुप्रवर्धन

एन०डी० जम्भले व एस०सी० पाटील

सारांश

इस अभिपत्र में आनुवंशिक श्रेष्ठता मालूम करने के लिए *युकेलिप्टस टेरेटिकार्निस* के कुछ श्रेष्ठ वृक्षों का ऊति-संवर्धन द्वारा प्रवर्धन कराने के परिणाम दिए गए हैं ।

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EFFECT OF SPACING AND PLANT DENSITY ON THE GROWTH OF POPLAR (*POPULUS DELTOIDES* BARTR. EX MARSH)

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Introduction

The Poplar (*Populus deltoides* Bartr. Ex Marsh.) is a fast growing tree and produces more biomass in short-rotation intensive culture than other deciduous or evergreen species (Dickmann and Stuart, 1983). It is also grown along with the farm crops as a substantial source of income in some of the developing countries of the world. In North India, Poplars are intercropped with wheat, soybean and other crops on the small land holdings. Since no attempts have been made so far to evaluate the performance of Poplar intercropped with field crops on various spacings and plant densities, it is difficult for the farmers to decide suitable tree density which can provide optimum yield of both crops and trees simultaneously. Hence, there is an urgent need to study the interaction of Poplar trees in conjunction with various field crops at various spacings and plant densities. An attempt has been, therefore, made to compare the various tree densities at various spacings for Poplar Cl. D-61 under Tarai conditions of Uttar Pradesh.

Materials and Methods

The studies were conducted at Agroforestry section of Horticultural Research Centre, Patherchatta, G.B. Pant University of Agriculture and Technology, Pantnagar during 1984 to 1990 using eight spacing at various plant densities viz. 5 x 5 m, 5 x 3.75 m, 5 x 2.5 m, 5 x 1.25 m, 5 x 1 m, 10 x 3.75 m (paired rows), 10 x 2.50 m (paired rows) and 10 x 1 m spacings corresponding to planting densities of 400, 533, 800, 1600, 2000, 533, 800 and 1000 trees ha^{-1}, respectively. The experiment was laid out in randomized block design having three replications. The cutting grown one year old plants of poplar clone D-61 were planted at various spacing in the plots of 20 x 20 m size having Mollisol soil (series VI of Patherchatta Sandy loam). The soils of the plantation site were well drained, neutral (pH 7.5) and rich in organic matter. The watertable of the plot remains within one metre during rainy season. The plots were cropped with uniform intercrops i.e., wheat-soybean for first three years and lemon grass (citronella) for latter three years leaving tree rows uncropped. A separate fertilizer dose was supplied to the respective crops as per their requirements. No separate fertilizer was given to the trees. The experimental plot was located at about 29^{0}N latitude, 79.3^{0}E longitude and 243.85 m above m.s.l. The summers are hot (32 to 43^{0}C) and dry, winters are cold (0^0 to 9^{0}C) and rainy season has heavy rainfall (average

1400 mm annum^{-1}). Monsoon occurs from third week of June to middle of September. Frost can be expected from last week of December to end of February. The data on survival, tree height, d.b.h., mean annual increment in d.b.h and basal area tree^{-1} were recorded in the month of August 1990 (6.5 years after transplanting). The total volume of wood underbark was calculated by the volume table of Poplar clone, G-48 (Chaturvedi, 1984).

Results and Discussion

The data presented in Table 1 reveals that various plant densities at various spacing significantly affected the survival, tree height, d.b.h., mean annual increment in d.b.h., basal area of the individual trees and volume of wood ha^{-1}. The survival was found highest at plant density of 400 trees ha^{-1} planted at 5 x 5 m spacing. This treatment was significantly superior than all other plant densities. However, other densities were statistically at par except 10 x 2.5 m (paired rows) spacing which gave lowest survival. Tree height was found significantly higher at 5 x 5 m spacing, however, this spacing was at par with 5 x 3.75 m, 5 x 2.5 m, 10 x 3.75 m (paired rows) and 10 x 2.5 m (paired rows) spacing and significantly higher than remaining treatments. Higher densities gave lower height of trees. D.B.H. was also found higher

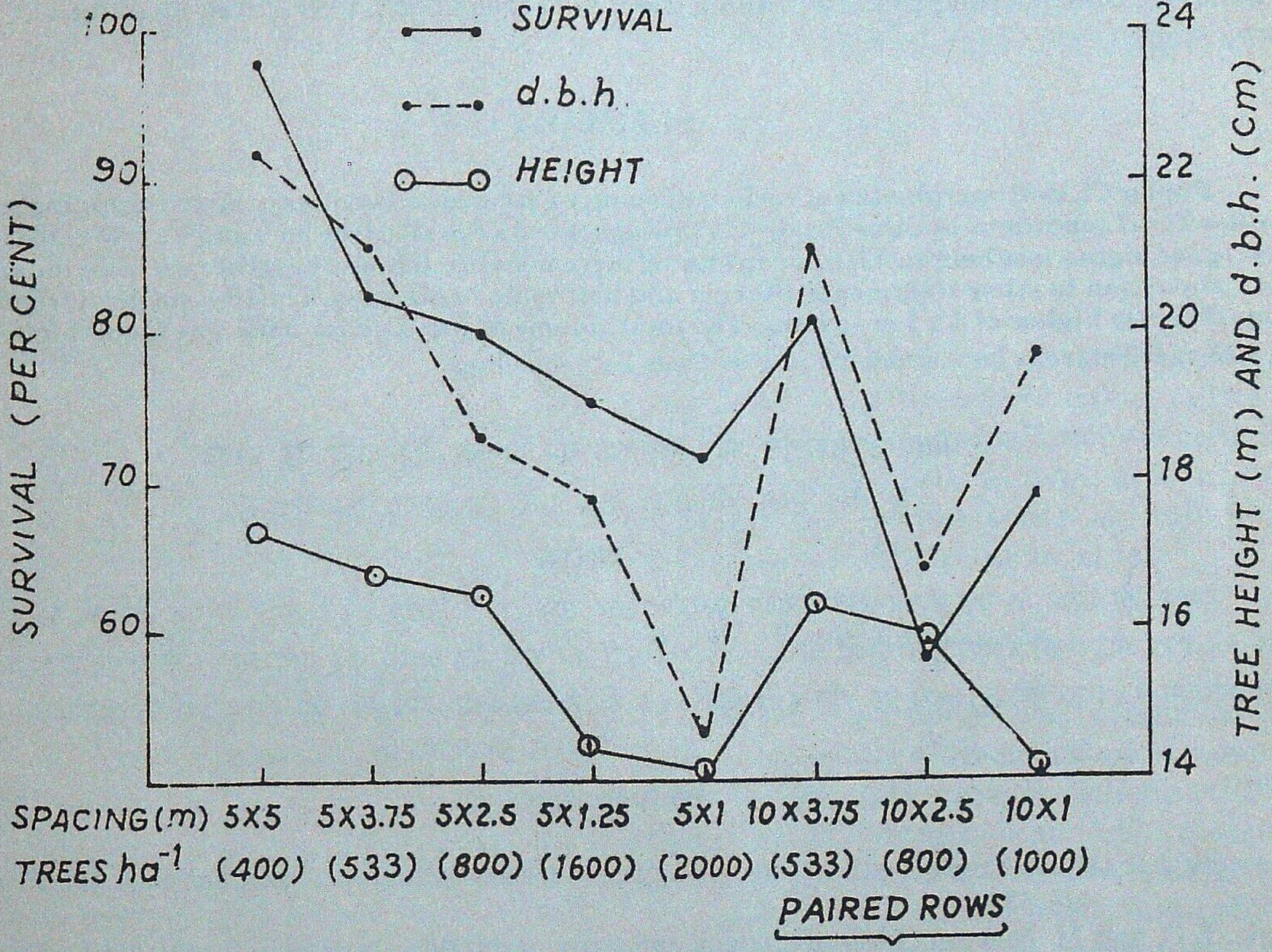
Table 1

Effect of tree spacing and density on survival and growth of Poplar.

Tree spacing	Plant density (No. of tree ha^{-1})	Survival (%)	Tree height (m)	d.b.h (cm)	Mean annual increment in d.b.h (cm)	Basal area tree^{-1} (m^2)	Total wood volume under bark (m^3 ha^{-1})
5 x 5 m	400	97.92 (85.19)	17.30	22.37	3.73	3.97	89.75
5 x 3.75 m	533	82.54 (65.83)	16.83	21.60	3.59	3.67	95.11
5 x 2.5 m	800	80.21 (64.33)	16.47	18.61	3.10	2.72	103.17
5 x 1.25 m	1600	75.52 (60.36)	14.43	17.76	2.96	2.51	166.78
5 x 1 m	2000	71.67 (57.90)	14.07	16.62	2.44	1.69	125.15
10 x 3.75 m (paired rows)	533	80.95 (64.63)	16.33	21.07	3.51	3.49	88.39
10 x 2.5 m (paired rows)	800	58.34 (49.82)	15.67	16.78	2.79	2.22	62.11
10 x 1.0 m	1000	69.17 (56.29)	14.00	19.72	3.29	3.07	109.27
S.Em±		(3.40)	0.51	0.79	0.13	0.25	11.24
C.D. at 5% level		(10.30)	1.55	2.40	0.39	0.77	34.10

Figures in parenthesis indicate transformed (Arcsin) values.

Fig. 1



Effect of tree spacing and density on performance of poplar

at 5 x 5 m spacing and this spacing was statistically similar with the spacings of 5 x 3.75 m and 10 x 3.75 m (paired rows) planting. Higher densities again produced lower d.b.h tree^{-1}. The mean annual increment in d.b.h. and the basal area followed the similar trend as d.b.h.

The mean annual increment in d.b.h. was lower with higher plant densities and reducing the plant density increased the mean annual increment in d.b.h. and the basal area tree^{-1}. The reduction in survival and growth with high density was due to the early competition within stands for mineral nutrients (Cole and Newton, 1986), soil water (Bassett, 1964) and light (Kozlowski *et al.*, 1991). Similarly, Parrotta (1988) also reported reduction in tree growth in the higher density stands of siris under Puerto Rico conditions. On the other hand, increased tree growth with low density plantations might be due to the more availability of light, water and nutrients resulting increase in crown size, leaf area and synthesis of carbohydrates and hormonal growth regulators. These changes might increase the downward transport of carbohydrates and hormonal growth regulators in the stem resulting eventual increase in cambial growth and redistribution of wood production along the tree stem.

The total volume of wood underbark ha^{-1} was found higher at spacing of 5 x 1.25 m and 5 x 1 m. This was due to more number of trees per ha^{-1} in these spacings.

SUMMARY

Poplar Cl. D-61 was planted at various spacing with various densities in mixed cropping system under Tarai conditions of Uttar Pradesh. Plant spacing 5 x 5 m (400 tree ha^{-1}) and 5 x 3.75 m (533 trees ha^{-1}) gave higher tree height, d.b.h, mean annual increment in d.b.h. and basal area of individual trees in comparison to other treatments after six and half years of planting. The tree survival was found significantly higher at 5 x 5 m spacing. The total volume of wood under bark was found higher at 5 x 1.25 m (1600 trees ha^{-1}) and 5 x 1 m (200 trees ha^{-1}) spacings.

पोपद अन्तरालन और सघनता का पापलर की वृद्धि पर प्रभाव

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सारांश

पोपलर की डी०- 61 क्लोन को विभिन्न पादप अन्तराल और सघनता पर रोपित करके अन्तः शस्यन करे पर 5 x 5 मीटर और 5 x 3.75 मीटर की रोपण दूरी रोपण के 6.5 वर्ष बाद पेड़ों की वृद्धि हेतु अच्छी पाई गयी लेकिन छाल रहित लकड़ी का कुल आयतन 5 x 1.25 मीटर (1600 पेड़ प्रति हे०) और 5 x 1 मीटर (2000 पेड़ प्रति हे०) की रोपण दूरी पर अधिकतम रहा।

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NUTRIENT CYCLING OF *EUCALYPTUS* PLANTATION IN RELATION TO STAND AGE IN AGROFORESTRY SYSTEM

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Introduction

The litter of the forest is an important stage in the cycle of habitat conservation. It provides the return of nutrients and the replenishment of organic matter and supports a wide variety of riches for fauna and micro-organisms. Annual litterfall, nutrient concentration in litter components and annual weight of nutrients in litterfall have been estimated for several forest species.

Fast growing short rotation trees depleted the soil more as compared to slow growing and long rotation ones (Prasad *et al.*, 1985). The potential benefit from growing tree combination with annual or perennial crops has been suggested by Nair (1984) in order to maintain and even enhance soil productivity.

With an increasing interest in the plantation forestry for bridging the gap between the demand and supply more and more land erstwhile not under forests is being devoted under tree plantations. In order to understand the functioning of such ecosystems, detailed studies on nutrient cycling are of paramount importance. The present study, therefore, was carried out to quantify the changes in soil chemical properties, total litter production, nutrient concentration and total addition of nutrients through litterfall to the soil under *Eucalyptus* hybrid trees as sole and intercropped with aromatic crops.

Materials and Methods

Field experiment was conducted at Central Institute of Medicinal and Aromatic Plants, Regional Centre, Pantnagar at 28°N latitude, 79.5°E longitude and 243.8 m above the sea level in the Tarai belt of Uttar Pradesh, India. The average rainfall of the area is 1835 mm. The maximum and minimum temperature ranges from 19 to 42°C and 6.10 to 26.10°C respectively. The field investigations were conducted for two years in a Randomised Block Design with three replicates.

Nine treatments namely 1. Pure *Eucalyptus* hybrid, 2. *Eucalyptus* hybrid + *Mentha arvensis*, 3. *Eucalyptus* hybrid + *Mentha piperita*, 4. *Eucalyptus* hybrid + *Mentha citrata*, 5. *Eucalyptus* hybrid + *Mentha spicata*, 6. *Eucalyptus* hybrid + *Mentha cardiaca*, 7. *Eucalyptus* hybrid + *Cymbopogon flexuouses*, 8. *Eucalyptus* hybrid + *Cymbopogon winterianus*,

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9. *Eucalyptus* hybrid + *Cymbopogon martinii* of juvenile (2 and 3 years) and adult (6 and 7 years) age tree were carried out.

The typic hapludoll soil of experimental plots derived from alluvium was clay-loam having bulk density of 1.35 gm/cm^3, average pH of 7.1, organic carbon 1.2%, available N, P and K of 345,22 and 183 kg/ha, respectively.

The litterfall of *Eucalyptus* hybrid in the pure and intercropped stands was recorded by collecting all the leaves, twigs, bark, and flowers falling on the soil surface in litter traps. The litter so collected were pooled together to represent annual fall. A representative sample of each annual litterfall from all the 9 treatments was taken and used to determine its dry weight and the contents of nutrients (N, P and K) present in them. Soil pits were excavated from pure and all the intercropped stands and bulk samples were collected from 0-15, 15-30, 30-45, 45-60, 60-75 and 75-90 cm depths. The total N, P and K in the litter was determined by modified micro-kjeldahl, Vanado-molybdophosphoric acid yellow colour method and flame photometry respectively.

The available nitrogen in soil was estimated by the method described by Subbiah and Asija (1956) using 0.32% $KmNO_4$ and 2.5% boric acid having a mixed indicator. The available phosphorus in the soil was determined by Olsen's bicarbonate method and the available potassium was extracted from the soil by neutral normal ammonium acetate as described by Jackson (1967).

On the basis of nutrient concentration in the litter the quantity of nutrients released and periodical addition to the soil was calculated.

Results and Discussion

Litter Production : The total annual litter production (t/ha/yr) was lower in the pure plantation in comparison to intercropped stands. In the pure stands it ranged between 0.68 to 7.65 while in the stands intercropped

Table 1

Total litter production (t/ha/yr±SE) in Eucalyptus hybrid as affected by age and treatments.

Stand No.	Species Mixture	Age of *Eucalyptus* hybrid (yrs.)			
		2	3	6	7
1.	*E*. Hybrid (pure)	0.68±0.012	2.31±0.034	6.12±0.41	7.65±0.36
2.	*E*. Hybrid + *M. arvensis*	0.83±0.014	2.90±0.038	6.28±0.42	8.25±0.42
3.	*E*. Hybrid + *M. piperita*	0.81±0.013	2.89±0.037	6.22±0.44	8.10±0.48
4.	*E*. Hybrid + *M. citrata*	0.80±0.012	2.88±0.036	6.20±0.41	7.98±0.44
5.	*E*. Hybrid + *M. spicata*	0.74±0.011	2.82±0.032	6.17±0.42	7.91±0.39
6.	*E*. Hybrid + *M. cardiaca*	0.75±0.012	2.86±0.033	6.18±0.45	7.93±0.42
7.	E. Hybrid + *C. flexuouses*	0.71±0.014	2.43±0.029	6.15±0.43	7.73±0.46
8.	*E*. Hybrid + *C. winterianus*	0.69±0.011	2.38±0.027	6.14±0.47	7.69±0.32
9.	*E*. Hybrid + *C. martinii*	0.73±0.012	2.75±0.030	6.16±0.46	7.88±0.48

CD (a) 5% for stand age 0.097, CD (b) 5% for species mixture NS, CD (a x b) 5% 0.292

Table 2

Nutrient concentration (mg/g±SE) in litterfall of Eucalyptus hybrid as affected by age and treatments

Stand No.	Species Mixture	Age of *Eucalyptus* hybrid (yrs.)			
		2	3	6	7
		N			
1.	*E.* Hybrid (pure)	8.4±0.11	7.0±0.36	5.1 ± 0.39	4.3 ±0.37
2.	*E.* Hybrid + *M. arvensis*	9.9 ±0.14	8.2 ±0.38	6.9 ±0.40	5.9 ±0.36
3.	*E.* Hybrid + *M. piperita*	9.8 ±0.15	8.1 ±0.32	6.8 ±0.42	5.7 ±0.34
4.	*E.* Hybrid + *M. citrata*	9.7 ±0.12	8.0 ±0.35	6.5 ±0.38	5.5±0.35
5.	*E.* Hybrid + *M. spicata*	9.5 ±0.13	7.8±0.34	6.0±0.41	5.0±0.40
6.	*E.* Hybrid + *M. cardiaca*	9.6 ±0.14	7.9±0.36	6.2±0.37	5.4±0.39
7.	*E.* Hybrid + *C. flexuouses*	9.2±0.15	7.6±0.34	5.7±0.36	4.6±0.38
8.	*E.* Hybrid + *C. winterianus*	8.9±0.12	7.4±0.37	5.5±0.42	4.5±0.32
9.	*E.* Hybrid + *C. martinii*	9.3±0.14	7.7±0.36	5.8±0.37	4.8±0.36

CD (a) 1% for stand age 0.390
CD (b) 1% for species mixture 0.586
CD (a x b) NS

		P			
1.	*E.* Hybrid (pure)	0.48±0.03	0.41±0.04	0.34±0.05	0.31±0.02
2.	*E.* Hybrid + *M. arvensis*	0.65±0.05	0.58±0.03	0.50±0.03	0.46±0.04
3.	*E.* Hybrid + *M. piperita*	0.62±0.03	0.55±0.05	0.47±0.02	0.43±0.05
4.	*E.* Hybrid + *M. citrata*	0.60±0.04	0.53±0.06	0.45±0.03	0.42±0.03
5.	*E.* Hybrid + *M. spicata*	0.57±0.02	0.50±0.05	0.42±0.04	0.39±0.04
6.	*E.* Hybrid + *M. cardiaca*	0.58±0.05	051±0.04	0.43±0.05	0.40±0.05
7.	*E.* Hybrid + *C. flexuouses*	0.54±0.03	0.47±0.03	0.39±0.03	0.36±0.04
8.	*E.* Hybrid + *C: winterianus*	0.53±0.03	0.46±0.04	0.38±0.02	0.35±0.03
9.	*E.* Hybrid + *C. martinii*	0.55±0.04	0.48±0.03	0.40±0.04	0.37±0.02

CD (a) 1% for stand age NS
CD (b) 1% for species mixture NS
CD (a x b) NS

		K			
1.	*E.* Hybrid (pure)	6.8±0.14	5.9±0.16	4.5±0.17	3.9±0.14
2.	*E.* Hybrid + *M. arvensis*	8.0±0.13	7.1±0.14	5.[illegible]±0.20	5.2±0.16
3.	*E.* Hybrid + *M. piperita*	7.8±0.14	6.9±0.12	5.5±0.18	5.1±0.11
4.	*E.* Hybrid + *M. citrata*	7.7 ±0.23	6.8±0.14	5.4±0.13	5.0±0.12
5.	*E.* Hybrid + *M. spicata*	7.5±0.25	6.6±0.16	5.2±0.14	4.8±0.14
6.	*E.* Hybrid + *M. cardiaca*	7.6±0.14	6.7±0.18	5.3±0.16	4.9±0.13
7.	*E.* Hybrid + *C. flexuouses*	7.2±0.23	6.3±0.19	4.9±0.18	4.4±0.15
8.	*E.* Hybrid + *C. winterians*	7.1±0.15	6.2±0.13	4.8±0.17	4.3±0.18
9.	*E.* Hybrid + *C. martinii*	7.3±0.13	6.4±0.20	5.0±0.15	4.5±0.12

CD (a) 1% for stand age 0.363
CD (b) 1% for species mixture 0.545
CD (a x b) NS

Table 3

Total addition of nutrients through litterfall (kg/ha/yr) of Eucalyptus hybrid as affected by age and treatments

Stand No.	Species Mixture	Age of *Eucalyptus* hybrid (yrs.)			
		2	3	6	7
		N			
1.	*E.* Hybrid (pure)	5.71	16.17	31.21	32.89
2.	*E.* Hybrid + *M. arvensis*	8.21	23.78	43.33	48.67
3.	*E.* Hybrid + *M. piperita*	7.93	23.40	42.29	46.17
4.	*E.* Hybrid + *M. citrata*	7.76	23.04	40.30	43.89
5.	*E.* Hybrid + *M. spicata*	7.03	21.99	37.02	39.55
6.	*E.* Hybrid + *M. cardiaca*	7.20	22.59	38.31	42.82
7.	*E.* Hybrid + *C. flexuouses*	6.53	18.46	35.05	35.55
8.	*E.* Hybrid + *C. winterianus*	6.14	17.61	33.77	34.60
9.	*E.* Hybrid + *C. martinii*	6.78	21.17	35.72	37.82

CD (a) 1% for stand age 1.090
CD (b) 1% for species mixture 1.635
CD (a x b) 1% 3.270

P

1.	*E.* Hybrid (pure)	0.32	0.94	2.08	2.37
2.	*E.* Hybrid + *M. arvensis*	0.53	1.68	3.14	3.79
3.	*E.* Hybrid + *M. piperita*	0.50	1.58	2.92	3.48
4.	*E.* Hybrid + *M. citrata*	0.48	1.52	2.79	3.35
5.	*E.* Hybrid + *M. spicata*	0.42	1.41	2.59	3.08
6.	*E.* Hybrid + *M. cardiaca*	0.43	1.45	2.65	3.17
7.	*E.* Hybrid + *C. flexuouses*	0.38	1.14	2.39	2.78
8.	*E.* Hybrid + *C. winterians*	0.36	1.09	2.33	2.69
9.	*E.* Hybrid + *C. martinii*	0.40	1.32	2.46	2.91

CD (a) 1% for stand age 0.424
CD (b) 1% for species mixture 0.636
CD (a x b) 1% 1.273

K

1.	*E.* Hybrid (pure)	4.60	13.62	27.54	29.83
2.	*E.* Hybrid + *M. arvensis*	6.64	20.59	35.79	42.90
3.	*E.* Hybrid + *M. piperita*	6.31	19.94	34.21	41.31
4.	*E.* Hybrid + *M. citrata*	6.16	19.58	33.48	39.90
5.	*E.* Hybrid + *M. spicata*	5.55	18.61	32.08	38.06
6.	*E.* Hybrid + *M. cardiaca*	5.70	19.16	32.75	38.85
7.	*E.* Hybrid + *C. flexuouses*	5.11	15.30	30.13	34.01
8.	*E.* Hybrid + *C. winterianus*	4.89	14.75	29.47	33.06
9.	*E.* Hybrid + *C. martinii*	5.32	17.60	30.80	35.46

CD (a) 1% for stand age 0.668
CD (b) 1% for species mixture 1.002
CD (a x b) 1% 2.005

Table 4

Available N, P, K (kg/ha) content of soil under Eucalyptus hybrid, as pure and intercropped with Mentha and Cymbopogon spp. at various ages

	Species Mixture											
Depth of Soil (cm)	Pure	*Mentha* spp.	*Cymbopogon* spp.	Pure	*Mentha* spp.	*Cymbopogon* spp.	Pure	*Mentha* spp.	*Cymbopogon* spp.	Pure	*Mentha* spp.	*Cymbopogon* spp.
	Age of *Eucalyptus* hybrid (yrs)											
	2			3			6			7		
						N						
0-15	418.2 (34.8)	350.5 (34.8)	372.1 (34.2)	422.2 (34.2)	356.0 (34.2)	379.2 (33.7)	427.2 (33.9)	363.4 (33.6)	385.1 (33.2)	432.4 (33.2)	371.2 (33.1)	392.2 (32.6)
15-30	231.6 (19.3)	188.8 (18.7)	211.2 (19.5)	236.6 (19.1)	194.2 (18.6)	217.2 (19.3)	240.8 (19.1)	201.4 (18.6)	223.1 (19.2)	242.4 (18.6)	208.2 (18.6)	229.4 (19.1)
30-45	181.2 (15.1)	168.2 (16.7)	175.4 (16.2)	186.4 (15.1)	174.4 (16.6)	182.4 (16.2)	192.2 (15.2)	179.8 (16.6)	187.2 (16.1)	199.4 (15.3)	185.2 (16.5)	194.4 (16.2)
45-60	157.8 (13.1)	132.1 (13.1)	142.5 (13.2)	164.4 (13.3)	137.1 (13.1)	148.9 (13.2)	168.4 (13.3)	144.1 (13.3)	154.2 (13.3)	172.5 (13.2)	151.2 (13.5)	162.8 (13.5)
60-75	114.2 (9.5)	88.5 (8.7)	96.4 (8.9)	121.2 (9.8)	94.4 (9.1)	104.4 (9.2)	125.4 (9.9)	101.0 (9.3)	111.8 (9.6)	134.4 (9.3)	107.2 (9.5)	121.4 (10.1)
75-90	96.1 (8.0)	78.2 (7.7)	82.2 (7.6)	103.4 (8.3)	85.2 (8.1)	91.2 (8.1)	105.2 (8.3)	90.8 (8.4)	97.8 (8.4)	118.4 (9.1)	96.6 (8.6)	102.2 (8.5)
Total	1199.1	1006.3	1079.8	1234.2	1040.3	1123.2	1259.5	1080.5	1159.2	1299.5	1119.6	1202.4
						P						
0-15	18.6 (23.5)	13.4 (22.8)	16.2 (23.9)	21.6 (22.1)	16.8 (21.4)	19.2 (21.7)	24.6 (20.9)	18.4 (20.4)	22.2 (20.6)	27.8 (20.2)	22.6 (19.4)	25.4 (20.3)
15-30	21.2 (26.8)	15.8 (26.9)	18.9 (27.9)	24.4 (25.0)	20.6 (26.2)	22.4 (25.3	28.2 (23.9)	23.2 (24.4)	25.8 (24.0)	32.2 (23.4)	27.0 (23.2)	28.6 (22.9)
30-45	14.5	11.6	12.4	17.8	14.6	16.1	20.6	17.8	19.2	23.6	21. 8	21.4

Contd...

	2			3			6			7		
	(18.3)	(19.8)	(18.3)	(18.2)	(18.6)	18.2	(17.5)	(18.7)	(17.8)	(17.1)	(18.7)	(17.9)
45-60	10.8 (13.6)	7.6 (13.0)	9.0 (13.2)	14.0 (14.3)	10.4 (13.2)	12.4 (14.0)	17.2 (14.6)	13.4 (14.1)	15.4 (14.3)	21.0 (15.2)	17.2 (14.8)	18.6 (14.9)
60-75	7.8 (9.8)	5.8 (9.9)	6.2 (9.1)	10.6 (10.8)	8.6 (10.9)	9.8 (11.1)	13.8 (11.7)	11.2 (11.7)	12.9 (12.0)	16.9 (12.2)	14.5 (12.4)	15.4 (12.3)
75-90	6.0 (7.6)	4.4 (7.5)	5.0 (7.3)	9.2 (9.4)	7.4 (9.4)	8.4 (9.5)	13.2 (11.2)	10.0 (10.5)	11.8 (10.9)	16.1 (11.9)	13.1 (11.2)	14.2 (11.4)
Total	78.9	58.6	67.7	97.6	78.4	88.3	117.6	95.0	107.3	137.6	116.2	124.6
						K						
0-15	280.2 (31.4)	263.6 (32.6)	272.4 (31.9)	286.4 (30.8)	268.6 (31.7)	277.4 (31.1)	293.4 (30.2)	274.4 (31.1)	284.2 (30.6)	299.2 (29.4)	282.1 (30.4)	285.4 (29.7)
15-30	199.6 (22.4)	183.5 (22.7)	192.4 (22.5)	204.2 (21.9)	190.1 (22.4)	199.1 (22.3)	212.6 (21.9)	196.2 (22.2)	204.6 (22.1)	222.6 (21.9)	203.2 (21.9)	211.3 (22.0)
30-45	138.4 (15.5)	124.4 (15.4)	131.2 (15.3)	145.2 (15.6)	131.8 (15.5)	137.4 (15.4)	151.4 (15.6)	137.2 (15.5)	143.3 (15.4)	158.2 (15.5)	143.4 (15.5)	148.6 15.5
45-60	116.2 (13.0)	103.5 (12.8)	111.4 (13.0)	121.4 (13.0)	110.4 (13.0)	117.5 (13.2)	128.0 (13.1)	117.1 (13.2)	122.0 (13.1)	134.2 (13.2)	123.2 (13.3)	128.2 (13.3)
60-75	88.4 (9.9)	74.5 (9.2)	82.4 (9.6)	95.6 (10.2)	81.2 (9.5)	88.1 (9.8)	102.4 (10.5)	87.2 (9.8)	96.4 (10.4)	108.2 (10.6)	96.2 (10.3)	101.4 (10.5)
75-90	68.2 (7.6)	57.5 (7.1)	64.2 (7.5)	76.8 (8.2)	64.5 (7.6)	71.2 (7.9)	83.2 (8.5)	71.2 (8.1)	77.4 (8.3)	92.2 (9.1)	78.4 (8.4)	84.5 (8.8)
Total	891.0	807.0	854.0	929.6	846.6	890.7	971.0	883.3	927.9	1014.6	926.5	959.4

Values in paranthesis indicate the per cent distribution of the nutrients at various depth of the soil with *Mentha* spp. it ranged from 0.74 to 8.25 and 0.69 to 7.88 in the stands intercropped with *Cymbopogon* spp. at various stages of their growth (Table 1). The difference in total litter production in the pure and various intercropped stands was not significant. The litter production was lower in the juvenile stands but it increased significantly ($P<0.05$) in the adult age. This increase in litter production was due to increase in the number of branches, twigs, and leaves of the plant with advancing age of the stands.

Nutrient Concentration in the litter : The concentration (mg/g) of N, P, K in the litter was found to be higher in the intercropped than that of pure stands at all the ages. The values remained highest in the stands intercropped with *Mentha* than *Cymbopogon* spp. being maximum in the *M. arvensis* and minimum in *C. winterianus* intercropped stands of all the ages (Table 2). The concentration of nutrients in the litter decreased significantly ($P<0.01$) with increasing age of the stands. This was due to increasing amount of retranslocation of the nutrients into the soil through the plants. The variation in the concentration of N and K in the intercropped stands at various ages was statistically significant ($P<0.01$).

Addition of nutrients into the soil : Through the concentration of nutrients decreased with increasing age of the stands but their total addition to the soil through litterfall was increased significantly ($P<0.01$) with increasing age (Table 3). This was due to significant increase in the total litter production with advancement of the age of the trees in the stands.

Available nutrient contents of the soil : The available N, P, K contents (kg/ha) of soil under the pure stands was found to be higher than the soil of the intercropped stands with *Mentha* and *Cymbopogon* spp. at various layers of the soil under the stands of various ages (Table 4). Most of the N (33-34%) and K (29-31%) contents were found to be maximum in the upper strata (0-15 cm) which decreased slowly with increasing depth of the soil and reached to 7-9% at the depth of 75-90cm. However, most of the P (22-26%) was accumulated in the soil at the depth of 15-30 cm. This was due to washing effect of the phosphorus already available in the upper strata (0-15 cm) of the soil and the phosphorus added through litterfall.

The type of vegetation grown under the tree also reflected soil property (Jacques *et al.*, 1975; Seth *et al.*, 1963). Therefore the available nutrients were found to be higher in the soil of the stands intercropped with *Cymbopogon* in comparison to *Mentha* spp. because *Mentha* spp. extract nutrients very rapidly from the soil while *Cymbopogon* draw it slowly. Similar findings in relation to available nutrients have been reported from different strata of the soil under the *Eucalyptus* hybrid and *Populus deltoides* pure as well as intercropped stands with *Cymbopogon* spp. (Singh *et al.*, 1989), *Pinus patula* (Pal *et al.*, 1985), *Eucalyptus globulus* and Black Wattle Plantations (Venkataramanan *et al.*, 1983).

SUMMARY

The annual litter production increased with increasing age of the *Eucalyptus* plantations both in the pure and intercropped stands with *Mentha* and *Cymbopogon* spp. An increase in litter production was recorded in all the intercropped in comparison to pure stands at all the ages. Higher concentration of N, P and K was observed in the litter of the intercropped stands which decreased with increasing ages of the stands. The total addition of nutrients through litterfall to the soil was higher in the intercropped than the pure stands. The N, P and K contents of the soil under the pure stands was higher than those of intercropped stands.. Maximum amount of N and K was found in the superficial layer of the soil which decreased with increasing depth. Most of the Phosphorus was accumulated in the soil at the depth of 15-30 cm in all the stands. The available N, P and K in the soil increased with increasing age of the stands.

कृषि वानिकी प्रणाली में चरण से संबंधित *युकेलिप्टस* रोपवन में पोष्याहार चक्रण

फैज़ मोहसिन, आर०पी० सिंह व के० सिंह

सारांश

युकेलिप्टस के शुद्ध और बीच-बीच में *मेन्था* और *सिम्बोपोगोन* प्रजातीय की फसल लगाए दोनों तरह के रोपवनों में उम्र बढ़ने के साथ-साथ वार्षिक आस्तरण उत्पादन बढ़ा । शुद्ध के मुकाबले में बीच-बीच में फसल लगे वनों में सभी उम्रों पर आस्तरण में वृद्धि होती देखी गई । बीच-बीच में फसल लगे वनों के आस्तरण में नाइट्रोजन, फास्फोरस और पोटाशियम का जमाव अधिक होता देखा गया जो रोपवन की उम्र बढ़ने के साथ घटता गया । पर्णास्तरण गिरने से मृदा में पोष्याहारों की कुल वृद्धि शुद्ध वनों की अपेक्षा बीच-बीच में फसल लगाए वनों में अधिक रही । शुद्ध वनों का नाइट्रोजन, फास्फोरस और पोटाशियम तत्व बीच-बीच में फसल लगाए वनों से अधिक पाया गया । नाइट्रोजन और पोटाशियम की अधिकतम मात्रा मृदा के ऊपर वाले स्तर में पाई गई जो गहराई बढ़ने के साथ घटती गई । फास्पोरस की अधिकांश मात्रा सभी वनों में 15-30 सेमी० गहराई वाली मृदा में जमा हुई थी । मृदा की उपलब्ध नाइट्रोजन, फास्फोरस और पोटाशियम मात्रा वनों की उम्र बढ़ने के साथ बढ़ गई ।

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STUDIES ON CHLOROPHYLL CONTENT AND DRY MATTER PRODUCTION IN BHIMAL (*GREWIA OPTIVA* DRUMMOND) SEEDLINGS

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Introduction

Bhimal (*Grewia optiva* Drummond) is an important multipurpose tree of West Himalayan region. It is a small to medium sized deciduous tree growing along boundaries of agricultural fields and provides excellent fodder, fuel and fibre. It excels all the other tree fodder in overall nutritive value (Negi, 1986). Considerable reports (Sharma *et al.,* 1966 b; Negi, 1977; Pal *et al.,* 1979; Khatta and Katoch, 1983, Joshi *et al.,* 1983; Verma and Mishra, 1989) are available on nutritive value of Bhimal leaves. But so far nothing has been reported on chlorophyll content and dry matter production in this species. Therefore, the present study was undertaken to determine chlorophyll content and dry matter production in Bhimal seedlings.

Materials and Methods

The experiment was conducted at the experimental plots of Botany Department, Kumaun University Campus, Almora during 1990-1991. The meteorological data of the study period (September, 1990-August, 1991) is given in Table 1. Maximum (29.1°C) and minimum (4°C) temperature was noted in the month of June and January respectively. Total rainfall during trial period was 1017.80 mm. Seeds of Bhimal were collected from their natural habitat and sown in polythene bags. One month old uniform seedlings were transplanted at the experimental plot. Chlorophyll content and dry matter production in the seedlings were recorded monthly from September, 1990 to August, 1991. The seedlings were harvested randomly and washed carefully for complete removal of soil from roots. For the estimation of dry matter production, seedlings were separated into its component parts i.e. root, stem and leaves. These were dried in an oven at 80°C for 48 hours and weighed. Chlorophyll content was extracted in 80% acetone and measured spectrophotometrically (Arnon, 1949). Each value is the average of three replicates.

Results and Discussion

Chlorophyll formation is affected by light, temperature, minerals, water and oxygen but it is very sensitive to almost any factor which disturbs metabolic process (Kramer and Kozlowski, 1979). Figure 1 depicts monthly variation of total chlorophyll. Total chlorophyll increased

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Table 1

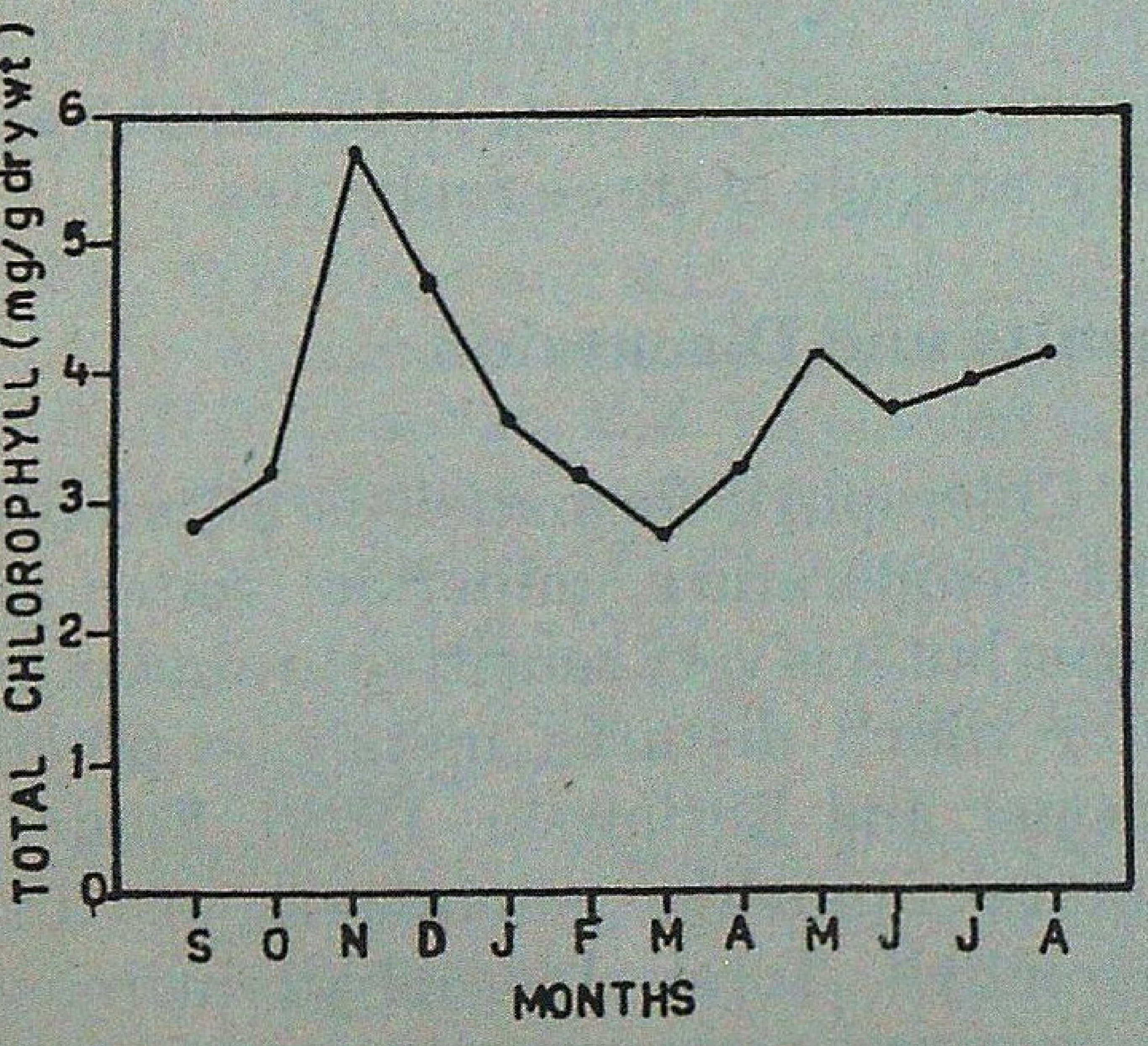
Meteorological data of the study period (September, 1990 - August, 1991)

Months	Temperature (°C)		Rainfall		Relative Humidity (%)
	Maximum	Minimum	Total rainfall (mm)	Number of rainy days	
September-90	25.5	17.5	172.4	12	77
October	23.1	11.6	9.0	2	46
November	20.8	8.4	15.6	4	42
December	18.5	5.6	105.0	3	41
January-91	14.2	4.0	8.4	1	48
February	17.6	5.6	50.2	4	29
March	20.9	9.0	77.1	5	36
April	24.4	13.0	38.0	4	34
May	29.0	18.0	31.0	7	37
June	29.1	19.0	46.1	6	78
July	28.0	20.0	125.0	12	57
August-91	25.3	18.7	340.0	18	85

Source : Vivekanand Parvatiya Krishi Anusandhan Shala (ICAR), Almora (U.P.)

from September to November till the maturity of leaves. This suggests that a close relationship occurred between chlorophyll and maturity of leaves. Maximum chlorophyll was recorded in the month on November when seedlings became well established. Kanan and Paliwal (1992) have studied chlorophyll in *Peltophorum ferrugineum* and *Albizia lebbek* seedlings and observed maximum chlorophyll content after establishment of seedlings. This is in agreement with observation of Bazzaz and Bliss (1971) also. Total chlorophyll decreased from December to March due to low synthesis of chlorophyll or breakdown of chlorophyll. Perry and Baldwin (1966) found that the first winter frost causes various degrees of breakdown of chloroplasts in several evergreen tree species. Since April onwards, total chlorophyll again increased with slight decline in month of June. This increase may be attributed due to warm climate and suitable moisture conditions, while a decline during June may be ascribed due to high temperature and bright light. Total chlorophyll in the plant was positively correlated with dry matter production (r=0.957. P<0.001). Mall *et al.* (1973) and Kakati and Yadava (1990) have also reported similar correlation in different plant communities. Chlorophyll a and b ranged

Fig. 1



Monthly variation of total chlorophyl

Table 2

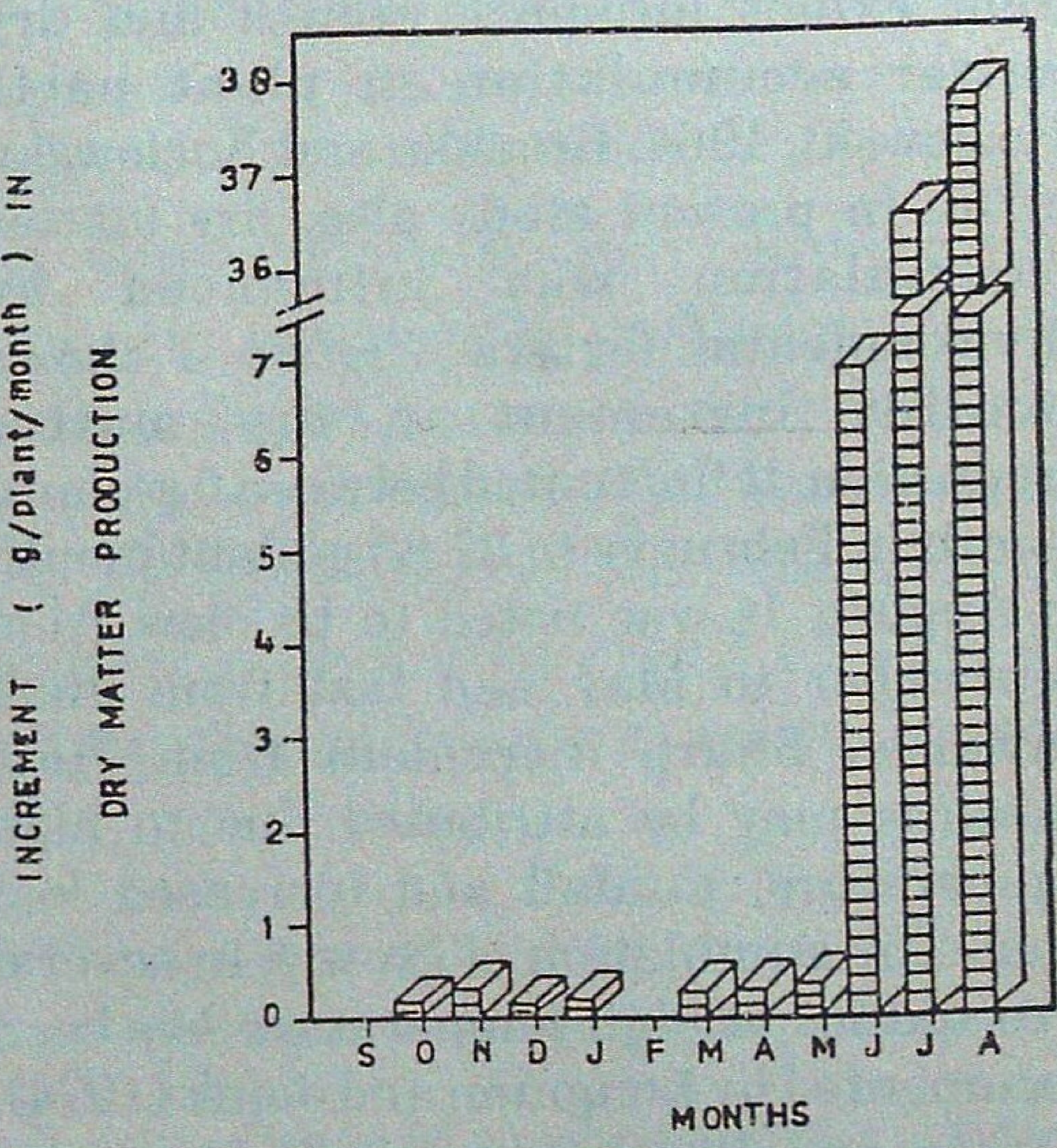
Monthly variation of chlorophyll (mg/g dry weight) and total dry matter production (g/plant) in Bhimal seedlings

Months	Chlorophyll			Total dry matter production
	Chl (a)	Chl (b)	Chl (a/b)	
September-90	1.68	1.09	1.54	0.054
October	1.83	1.41	1.30	0.229
November	3.65	2.01	1.82	0.562
December	2.84	1.87	1.52	0.710
January-91	2.29	1.31	1.75	0.895
February	1.95	1.24	1.57	0.856
March	1.65	1.05	1.57	1.120
April	1.79	1.43	1.25	1.390
May	2.20	1.95	1.13	1.710
June	2.07	1.65	1.25	8.500
July	2.43	1.44	1.69	44.960
August-91	2.29	1.79	1.28	82.790

from 1.65 to 3.65 mg/g dry wt. and 1.05 to 2.01 mg/g dry wt. respectively (Table 2). Chlorophyll a/b ratio was higher than one and fluctuated throughout the study period between 1.13 to 1.82. This indicates that chlorophyll a was more abundant than chlorophyll b. This is in accordance with the findings of Rauzi and Dobrenz (1970) and Joshi (1988) in different plant species.

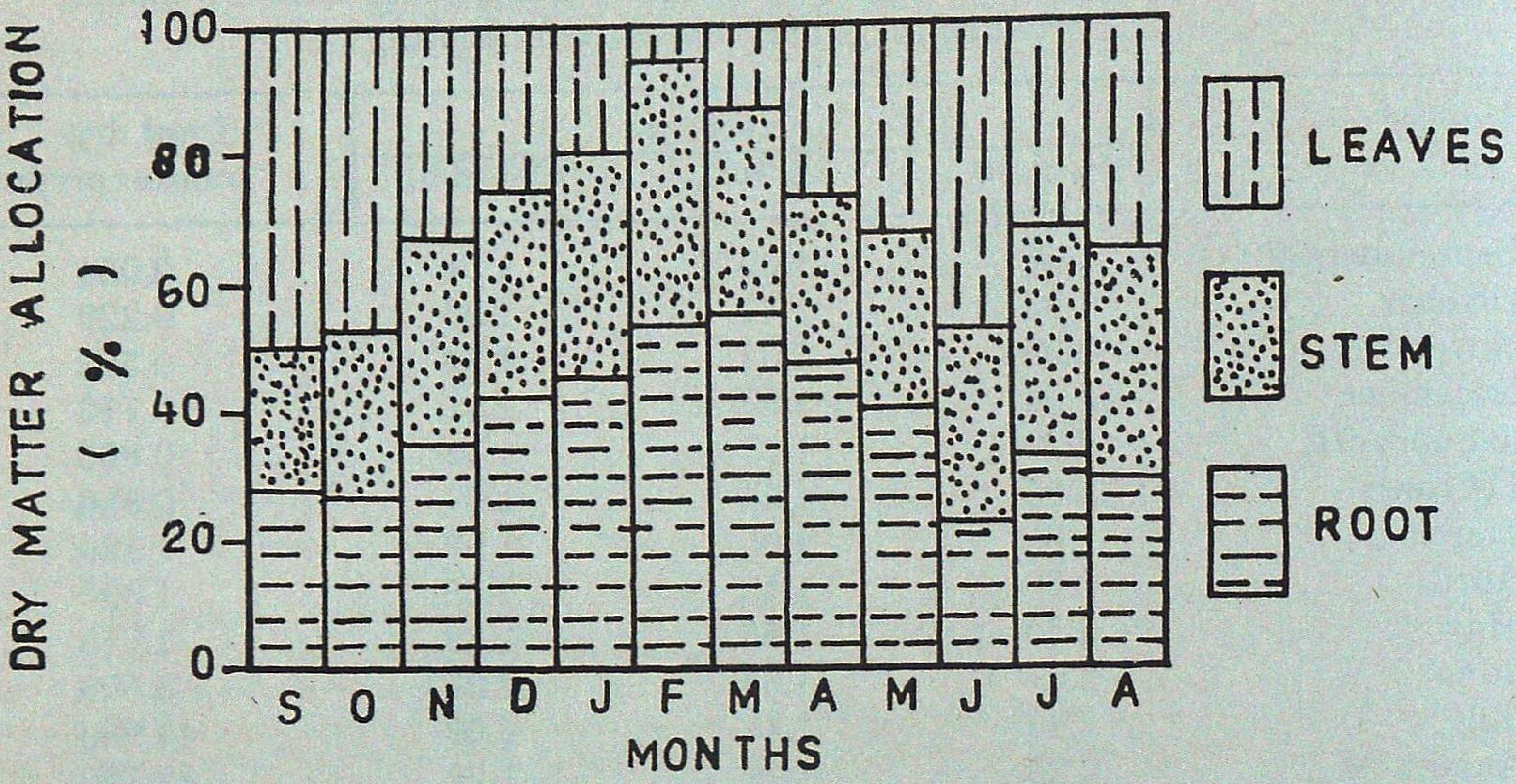
Knowledge of dry matter production by the seedlings is useful in the studies of photosynthetic capture and dry matter production of trees (Mishra and Bhatnagar, 1987). Table 2 reveals monthly dry matter production in seedlings. Dry matter production gradually increased with slight decline in the month of February. In Bhimal, old leaves are shed in March and new leaves appear in April-May (Brandis, 1906). Thus dry matter production declined due to reduction in leaf dry matter production caused by leaf fall. In other tree species also, a decrease in leaf dry matter production due to leaf fall has been reported (Singh *et al.*, 1982; Mishra and Bhatnagar, 1987). One year old seedlings attained total dry matter production of 82.79 g/plant.

Fig. 2



Monthly increment in dry matter production.

Fig. 3



Dry matter allocation (%) in diffrent plant parts.

External environmental factors to a great extent influence growth and dry matter accumulation in plant parts (Kozlowski, 1964; Braekke and Kozlowski, 1975). In present study also, dry matter accumulation was influenced by environmental factors. Figure 2 shows monthly increment in dry matter production. It fluctuated between 0 g/plant/month in February to 37.83 g/plant/month in August. It was noted to be slow from September to May and fast from June onwards. Sharp increment from June onwards may be attributed due to high temperature, rainfall and increased leaf area. The stimulation of growth in several tree species at high temperature has been documented by Longman and Jenik (1974). Mishra and Bhatnagar (1987) have also reported increased growth in *Moringa oleifera* seedlings due to high temperature.

The percentage allocation of dry matter in different plant parts is illustrated in Figure 3. The contribution of leaf was maximum in one month old seedlings. It gradually decreased till February and then increased till the last month. This trend is consistent with the observations of Mishra and Bhatnagar (1987) in *Moringa oleifera* seedlings. The contribution of root was found to be more than that of stem in early establishment period upto the age of nine months i.e. till May. During the last three months, the opposite trend was noted. This suggests that in old age, there was translocation of nutrients in above ground part to maximize the dry matter production in stem and leaves. The average contribution of root, stem and leaves was 37.86%, 30.96% and 31.18% respectively. It is clear that the contribution of root was maximum. This is in accordance with the findings of Singh *et al.* (1982) in other tree species. On contrary to this finding, some workers (Mishra and Bhatnagar, 1987; Singh and Gupta, 1990) have reported the contribution of root at number two. These contradictory findings may be attributed due to difference in plant species and climatic factors. Root development of plant species depends on a number of site and environmental condition (Dadhwal and Narain, 1988). The contribution of root at number one indicates that Bhimal has strong and wide spreading root system and the contribution of leaf at number two suggests the nature of providing large quantity of fodder leaves in Bhimal. Plantation of Bhimal should be given priority in agroforestry research programmes.

Acknowledgements

The author is extremely grateful to Dr. K.R. Verma, Reader, Department of Botany, Kumaun University Campus, Almora for valuable suggestions, guidance and help and to the Head of the Department for providing necessary facilities.

SUMMARY

Total chlorophyll content and dry matter production in Bhimal seedlings were studied at Almora District in Kumaun Region. Total chlorophyll increased from September to November and decreased from December to March. Since April onwards, it again increased with slight decline in June due to high temperature. Chlorophyll a/b ratio was higher than one ranging from 1.13 to 1.82. Total chlorophyll in plant was positively correlated with dry matter production (r=0.957. P<0.001). One year old seedlings attained total dry matter production of 82.79 g/plant. It gradually increased till August with slight decline in February. Monthly increment in dry matter production was recorded to be maximum (37.83 g/plant/month) in August and minimum (0 g/plant/month) in February. The average contribution of root to total dry matter production was maximum (37.86%) followed by leaves (31.18%) and stem (30.96%).

भीमल (*ग्रीविया ऑप्टिवा* ड्रमंड) पौधे के पर्णशाद तत्व और शुष्क पदार्थ उत्पादन का अध्ययन

स्नेह लता

सारांश

भीमल के पौधों के पर्णशाद तत्व और शुष्क पदार्थ उत्पादन का अध्ययन कुमाऊँ क्षेत्र के अल्मोड़ा जिले में किया गया। सितम्बर से नवम्बर तक इसका पर्णशाद बढ़ा और दिसम्बर से मार्च तक घटा। अप्रैल के बाद जून में अधिक तापमान के कारण हुई मामूली घटत सहित यह बढ़ता गया। पर्णशाद ए/बी का अनुपात एक से अधिक 1.13 से 1.82 की परिसीमा में रहा। पौधें के कुल पर्णशाद का शुष्क पदार्थ उत्पादन के साथ धन सहसम्बन्ध रहा (r= 0.957, P<0.001)। एक वर्षीय पौधे का कुल शुष्क पदार्थ 82.79 ग्राम/पौधा तक पहुँचा। अगस्त तक यह धीरे-धीरे बढ़ा, फरवरी में थोड़ा घट गया। शुष्क पदार्थ उत्पादन की मासिक संवृद्धि अधिकतम (37.83 ग्राम/पौधा/मास) अगस्त में तथा न्यूनतम (0 ग्राम/पौधा/मास) फरवरी में रही। शुष्क पदार्थ उत्पादन में जड़ों का योगदान अधिकतम (37.86%) और उसके बाद क्रमशः पत्तियों (31.18%) और तने (30.96%) का योगदान रहा।

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RESEARCH NOTES

(I)

SALVADORA PERSICA - A NEW HOST RECORD FOR *CATOPSILIA CROCALE* CRAM. (LEPIDOPTERA : PIERIDAE)

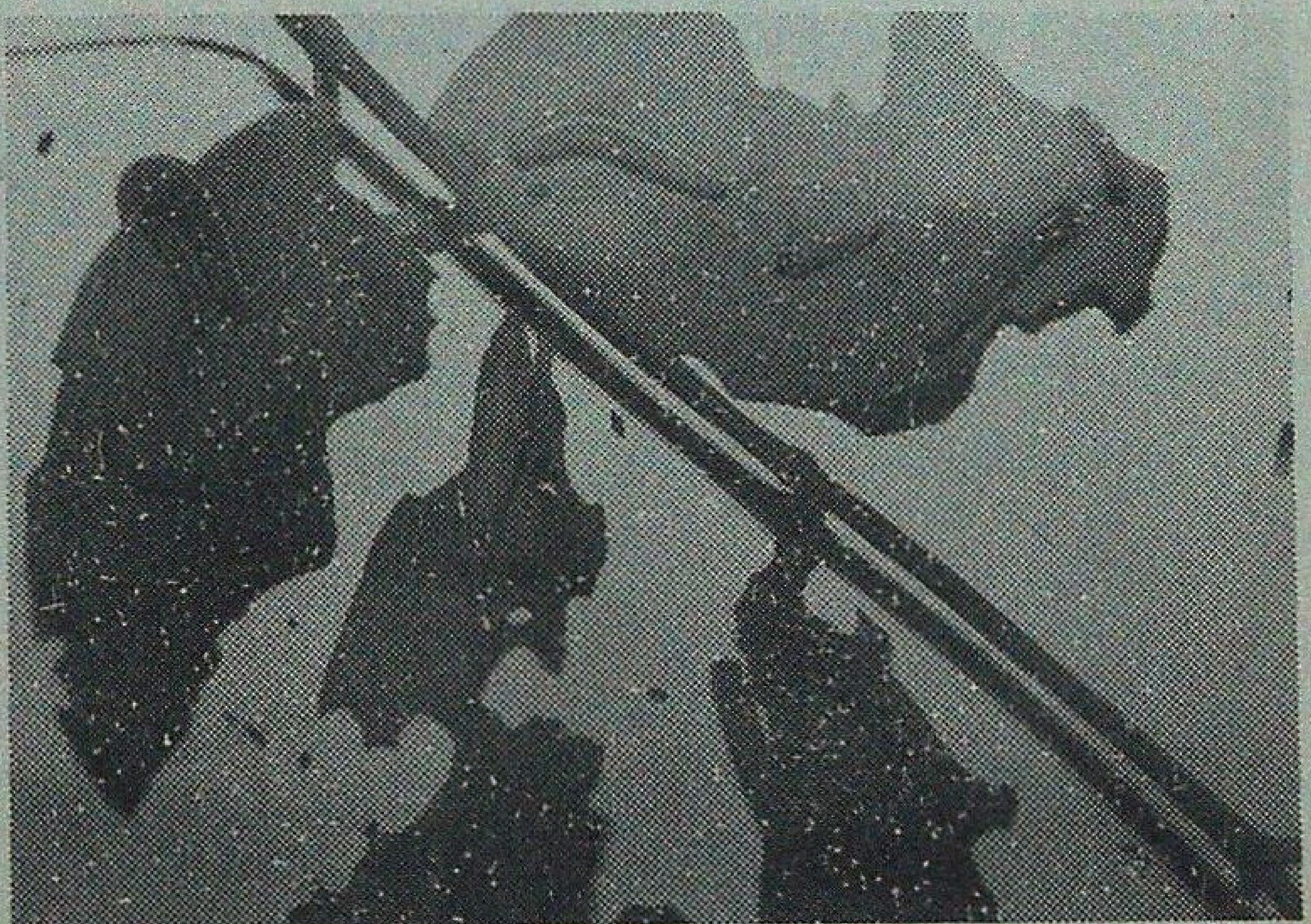
Catopsilia crocale Cram. (Lepidoptera : Pieridae) commonly known as Amalthas defoliator is a well known pest of *Cassia fistula*. It is also reported severely defoliating the leaves of *Albizia* sp, *Bauhinia racemosa, Butea frondosa, Cassia jawanica, Cassia siamea* and *Cassia tora* in India and its neighbouring countries. (Beeson, 1941; Browne, 1968; Ahmed and Srivastava, 1991; Joshi *et al.*, 1991).

Salvadora persica commonly known as 'Jaal' is a large much-branched evergreen small tree found in the dry and arid regions of India and on saline lands and in coastal regions just above the high-water mark. The tree is suitable for growing in shelter-beds and as wind breaks for protecting the farm habitations, gardens, orchards, ect. The leaves are used as camel fodder.

The adult butterfly is lemon yellow in colour and are active fliers. The eggs are white, conical, minute and laid singly on the tender leaves. The eggs turn yellow before hatching. Eggs hatch in 6-7 days into a light green larvae which feeds on epidermal tissues of the young leaves. The full grown caterpillar is green, naked with small black tubercles and a lemon yellow mid dorsal line. It measures 48mm in length. Larval period last for 18-20 days. Pupation takes place on twigs and leaves. Pupa is light green in colour, 18-20 mm in length. Adult emerges in 10-12 days. Lifecycle is completed in 34-39 days. The caterpillar feeds on the entire leaf leaving the harder mid-rib and petiole intact. the heavy defoliation due to the caterpillars of these species results in the mortality of young plants and malformation of the healthy shoots.

Larvae of *Catopsilia crocale* Cram has been recorded feeding on *Salvadora persica* (Fig. 1) seedlings at nursery of Arid Forest Research Institute, Jodhpur. The larvae are found throughout the year. The population of larvae was at its maximum during the months of August-October due to the optimum conditions of abiotic factors like temperature, relative humidity, rainfall and food for their development and metabolic activities. This is the first report of *Catopsilia crocale* Cram from *Salvadora persica*.

Fig. 1



Caterpillar of *Catopsilia crocale* feeding on leaves of *Salvadora persica*

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(II)

SEED COLLECTION AND NURSERY EMERGENCE IN *QUERCUS SEMECARPIFOLIA* (SMITH)

Introduction

Quercus semecarpifolia locally known as Kharsu Oak occurs in regions of moderate to heavy snowfall in the Himalayas from Bhutan westwards, generally between 2400 to 3000 m elevation. It is a common associate of fir and spruce. Occasionally it grows down to 2000 m and upto about 3600 m elevation especially on northern and southern aspects respectively. In its zone of occurrence, it is gregarious and forms pure stands on the hill slopes and upper slopes of the ridges (Troup, 1921). The trees are lopped extensively near the habitations in the hills of Himachal Pradesh and Uttar Pradesh for fodder as its leaves are considered best fodder (Gorrie, 1937; Laurie, 1939; Shabnam, 1959).

As natural regeneration of Kharsu Oak is abundant, Chandra (1952) suggested that artificial regeneration is not required. This was the position then, but now-a-days tremendous grazing, heavy lopping and the difficulty in enforcing strict closure under the changed socio-economic mileau, artificial regeneration has to be resorted to as an alternative or at best to supplement natural regeneration.

Troup (1921) showed that acorns of Kharsu Oak ripen in July/August and they germinate readily after falling to the ground. Information neither on exact time of acorn collection nor on depth of sowing and acorn weight versus germination is available. Hence, the present study has been undertaken.

Materials and Methods

The acorns of Kharsu Oak were collected during 1991, from the first week of July and weekly collections were made thereafter till the availability of acorns, from Hattu forests near Narkanda, situated at an elevation ranging from 3000-3400 m. The study was carried out in Nihari Research Nursery (2850 m) in Kotgarh Forest Division of Himachal Pradesh.

To find out the exact time of acorn collection, weekly collection was done from first week of July to second week of August, 1991. Forty acorns were sown in lines 25 cm apart in nursery bed of 1 x 1 m size. Each treatment was replicated four times in randomized block design. Acorns collected in third week of July, 1991 were taken for experiments to find out the optimum depth of acorn sowing in nursery and acorn weight effect on germination. In depth of sowing, acorns were sown 2, 3, 4, 5 and 6 cm deep in good textured soil. Each treatment was replicated four times.

Acorns were graded in three lots of upto 5 g, 5-10 g and 10-15 g to study the effect of its weight on germination. Each treatment was replicated seven times in randomized block design with 40 acrons in each bed of 1x1 m. In all the experiments acorn sowing was done within 24 hours of its collection. Weeding and watering of germination beds was done as and when required.

Results and Discussion

Germination started after 20 days of sowing and continued upto one year i.e. upto July, 1992. Roughly 30% of germination was completed before snowfall. Datas on germination percentage was statistically analysed after angular transformations as given below (Table 1-3).

Table 1

Germination of Kharsu Oak as affected by time of collection

Date of acorn collection sowing in 1991	Germination percentage 1992	C.D. Value
Ist week of July	36.25	10.97 - 1%
IInd week of July	88.62	7.86 - 5%
IIIrd week of July	79.37	
IVth week of July	73.12	
Ist week of August	10.62	
IInd week of August	3.25	

Table 2

Germination of Kharsu Oak as affected by depth of sowing

Acorn Depth (cm)	Germination percentage September, 1992	C.D. Value
2	89.38	9.77-1%
3	82.81	8.32-5%
4	77.56	
5	75.31	
6	66.09	

Table 3

Germination of Kharsu Oak as affected by acorn weight

Acorn weight (g)	Germination percentage September, 1992	C.D. Value
Upto 5	48.93	4.90 - 1%
5 - 10	60.36	4.16 - 5%
10 - 15	86.25	

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(III)

ZEUXINE DEBRAJIANA CHOWDHURY *SP. NOV.* - A NEW SPECIES OF ORCHIDS FROM ASSAM, INDIA.

Zeuxine strateumaticae (L.) Schltr. affinis, sed differt bulbo discoideo, cauli cum folis paucis sine marginibus incurvis, spica laxiflora, sepalis basi extus pubescentibus, labelli epichilore cum 2 lobis patentibus oblongis truncatis, ovario pubescenti.

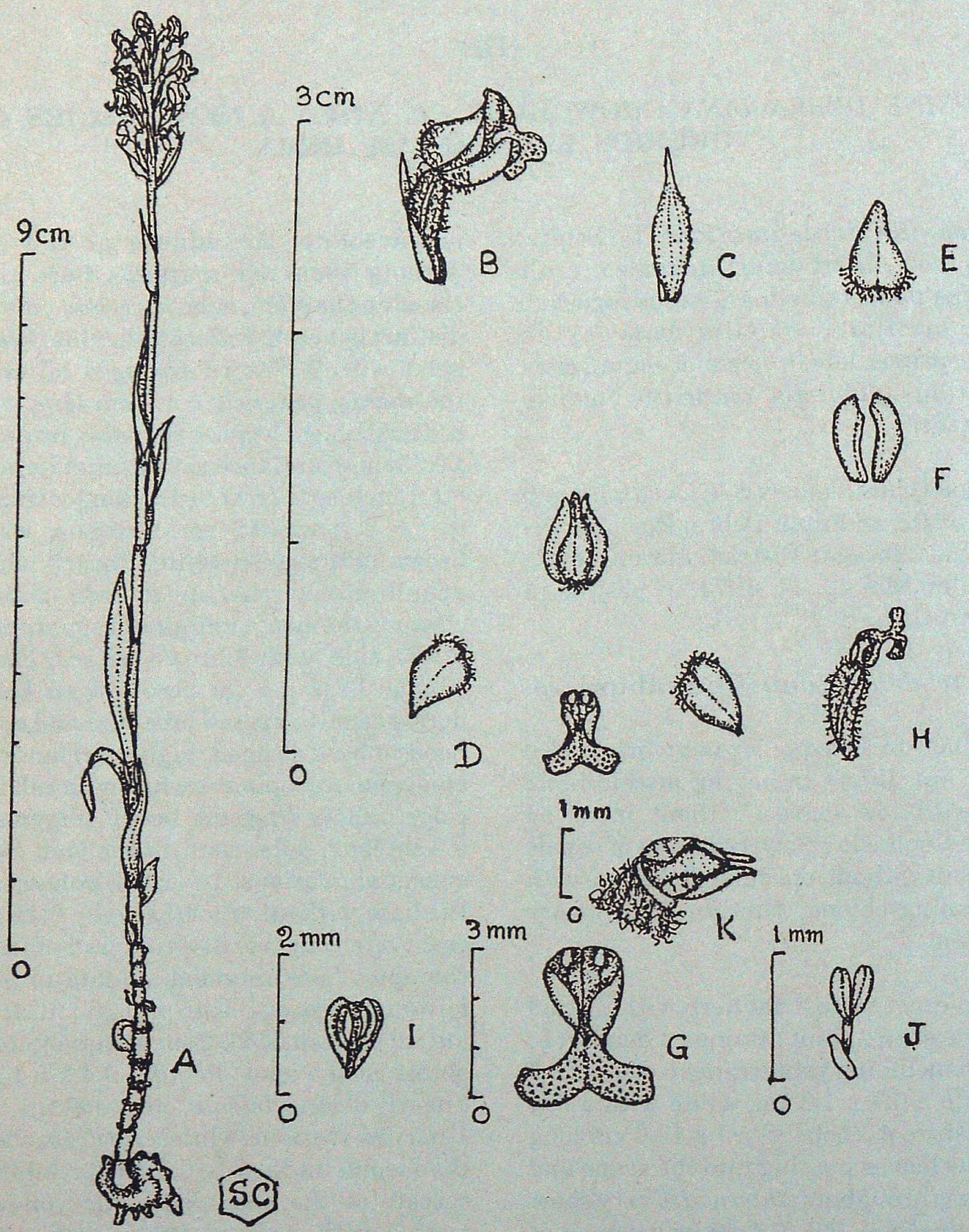
Holotypus lectus a *S. Chowdhury* sub numero 502, ad locum Debraj Roy College, Golaghat, Sibsagar District, Assam, India, alt. *c* 30m, die 22. 11. 1974, et positus in herbario CAL.

***Zeuxine debrajiana* Chowdhury *sp. nov.*.**

Allied to *Zeuxine strateumaticae* (L.) Schltr. but differs in having discoid bulb, stem with few leaves without incurved margins, spike lax flowered, base of sepals pubescent without, epichile of labellum with 2 spreading oblong truncate lobes, ovary pubescent.

An erect terrestrial herb with discoid bulb, the entire plant attained a height of *c* 16.5 cm including subterranean stem of 2.5 cm. *Bulb c* 0.7 x 1.2 cm, white with a few brownish root knobs. *Stem c* 13.0 cm long with few leaves passing into the scape and glabrous throughout, *internodes* very short at proximal end, 0.3 - 0.4 cm long, longer at distal end, 0.9 - 2.2 cm. *Leaves* sessile, linear bract like near the surface of the soil, *c* 0.5 - 0.25 cm, longer and broader at distal end, 1.3 - 3.0 x 0.3 - 0.5 cm, lanceolate to oblanceolate. Acuminate at the apex, without incurved margins, base partly clasping the stem, subcoriaceous, mid-vein distinct beneath. *Inflorescence* lax flowered spike with 9 flowers arranged all around the rachis; *peduncle c* 1.6 cm long with a solitary bract clasping the base; *bract c* 1.2 x 0.35 cm, ovate lanceolate acuminate; *rachis c* 2.0 cm long. *Floral bracts* longer than the ovary, *c* 0.8 x 0.2 cm, scarious, whitish brown to brownish white, linearly oblong, acuminate at the apex, base cuneate, clasping the ovary, margins finely crenulate at one side, with 3 brown nerves. *Flowers* sessile 0.6 x 0.4 cm across from base of dorsal sepal to apex of labellum and apex of hood to base of hood, highly zygomorphic, epigynous, resupinate, white with yellowish tinge, mildly fragrant; *ovary* epigynous, *c* 0.6 cm long, pubescent throughout. *Sepals* subequal, scarious, 1-nerved, pubescent at the base without; *dorsal sepal c* 0.45 x 0.3 cm. ovate concave, deflexed and obtuse at the apex, base rounded, adnate to petals forming a hood, *c* 0.45 x 0.35 cm across; *lateral sepals* 0.35 x 0.2 cm, obliquely oblong, obtuse at the apex. *Petals c* 0.4 x 0.15 cm, linearly oblong, falcate, obtuse at the apex, 1-nerved, scarious, white. *Labellum* shorter than *sepals* and *petals*, 0.3 x 0.3, cymbiform, saccate at the base; *hypochile* yellow, 3-nerved with 2 small fleshy calli on two lateral nerves; *epichile* white, bilobed at the apex, lobes oblong, spreading, truncate, minutely papillose, fleshy. *Column* inconspicuous *c* 0.15 cm long with 2 white

Fig. 1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Zeuxine debrajiana Chowdhury

A- habit of the plant; B - Flower; C - floral bract; D - sepals, petals and labellum; E - sepal; F - petals; G - labellum; H - column with labellum on ovary; I - operculum; J - pollinia; K - column with rostellum (All drawn by the author from live specimen of Field No *Chowdhury* 502 on 25.11.1974 flaplike wings covering the operculum; *rostellum* deeply cleft, nearly parallel, green; *operculum c* 0.1 x 0.1 cm, ovate, beaked at the apex, reddish pink centre, margins white. *Pollinia* in 2 pairs, clavate, attached within the tip of the short oblong yelow *caudicle* joined to a linearly oblong white *gland.* (Fig. 1).

Flowers : November.

Habitat : Growing in open place amidst spp of *Imperata* and *Chrysopogon.* India: Assam, Sibsagar District (presently Golaghat District), in front of Botany Department of Debraj Roy College, Golaghat (*c* 26°, 29' N and 93° 56' E), 22nd November, 1974, *S. Chowdhury* 502 (Holotype CAL).

Note: A single complete plant in full bloom was collected accidentally on 22nd November, 1974 with unusual development of a discoid bulb. The second specimen of the same could not be collected as yet probably due to its rare occurrence amidst grasses which are frequently cut down to clear the College compound.

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(IV)

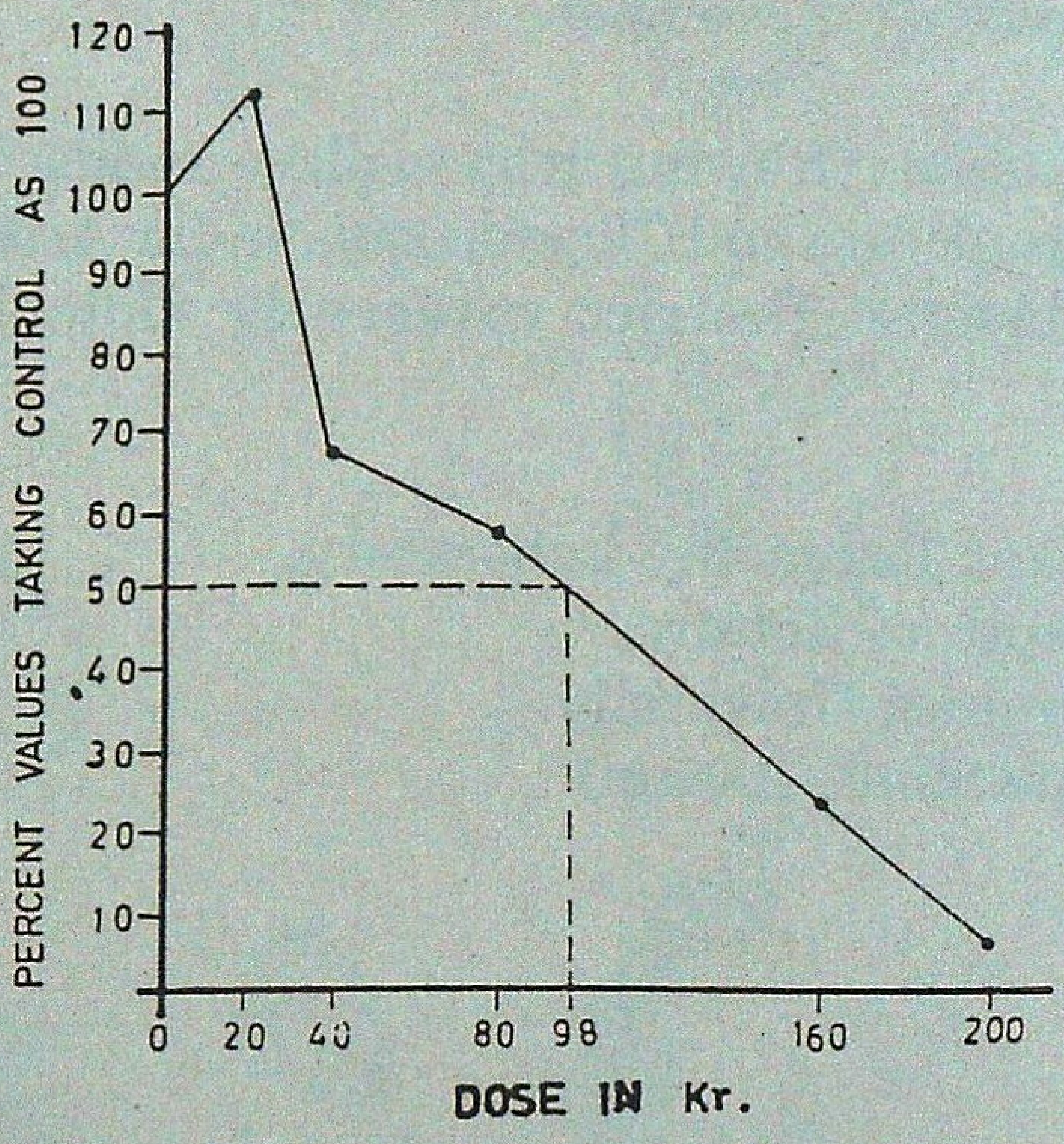
RADIOSENSITIVITY OF *ACACIA CATECHU* WILLD. TO GAMMA RAYS

Mutation breeding has played a significant role in genetic improvement of many agricultural and horticultural plants. Gustafsson (1960) has suggested the importance of mutational breeding in forestry. *Acacia catechu* is mainly grown for production of Cutch and Katha which is extracted from its heart wood. The yield of Katha depends on the heartwood volume (Anon, 1973). There seems to be a good scope for increasing the ratio of heartwood to sap wood by inducing variation and mutation breeding could be a probable answer to this.

For any successful mutation breeding programme it is an essential prerequisite to ascertain the effect of mutagens/ radiosensitivity to different parameters. In the present study various traits of *Acacia catechu* were studied to assess their ratiosensitivity.

In a preliminary study air dried seeds (moisture 10.76%) of *Acacia catechu* were irradiated with gamma rays at dose rate 30 r/sec from a Cobalt 60 source. Two sets of experiments were conducted. In the first set of experiment the doses given were 10, 10, 30 and 40 Kr. and in the second set the doses given were 20, 40, 80, 160 and 200 Kr. This was done so as in the lower doses the LD-50 value for germination could not be achieved. The irradiated seeds were sown in pots having a mixture of soil, sand, and manure in the ratio of 3:1:1. Twenty five seeds/ replicate/ treatment were sown in four replicate. Data were recorded daily for germination, survival. Seedling height was measured at age of 45 days. From daily germination count germination value (GV) was calculated as described by Czabator (1962). LD-50 value was calculated for germination as per method described by El-Lakany and Sziklai (1975).

Fig. 1



Effect of gamma rays on germination of seeds of *Acacia catechu*

With the increase in dose of gamma rays there was diminutive effect on germination except at dose 20 Kr wherein slight stimulatory effect (+ 14%) in germination was observed. More or less a linear trend was also observed in case of survival of seedling recorded at age 3 weeks. Total lethality was observed in the treatments beyond done 20 Kr. at age 45 days when plant height was recorded. In

Table 1

Analysis of variance for germination, germination value, survival and height of plants of Acacia catechu following gamma irradiation of seeds.

Source of Variation	d.f.	Germination	GV	Survival	d.f.	Height
			MS			
Replication	3	147.1396^{NS}	3.478	197.9823^{NS}	3	10.2826
Treatment	4	326.7386.	5.995^{*}	1333.3839	2	55.6640
Error	12	80.4345	1.832	92.4116	6	2.4638

NS - Not significant
* - Significant at 5% level of probability.
*** - Significant at 0.1% level of probability.

the present study the LD-50 dose for germination worked out was 98 Kr. but so far as the survival of plant is concerned hundred per cent mortality was observed beyond dose 20 Kr. at age 45 days. One of the possible reasons for poor survival of plants may be the poor development of radicle which was severely effected by radiation. The observations suggest that due consideration should be given to survival of plants for deciding doses as the ultimate selection of mutants will depend on survival of plants. Analysis of variance was carried out and the differences due to treatments were found significant to very highly significant (Table 1) for various parameters.

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Division of Genetics and Tree Propagation,
Forest Research Institute,
Dehra Dun.

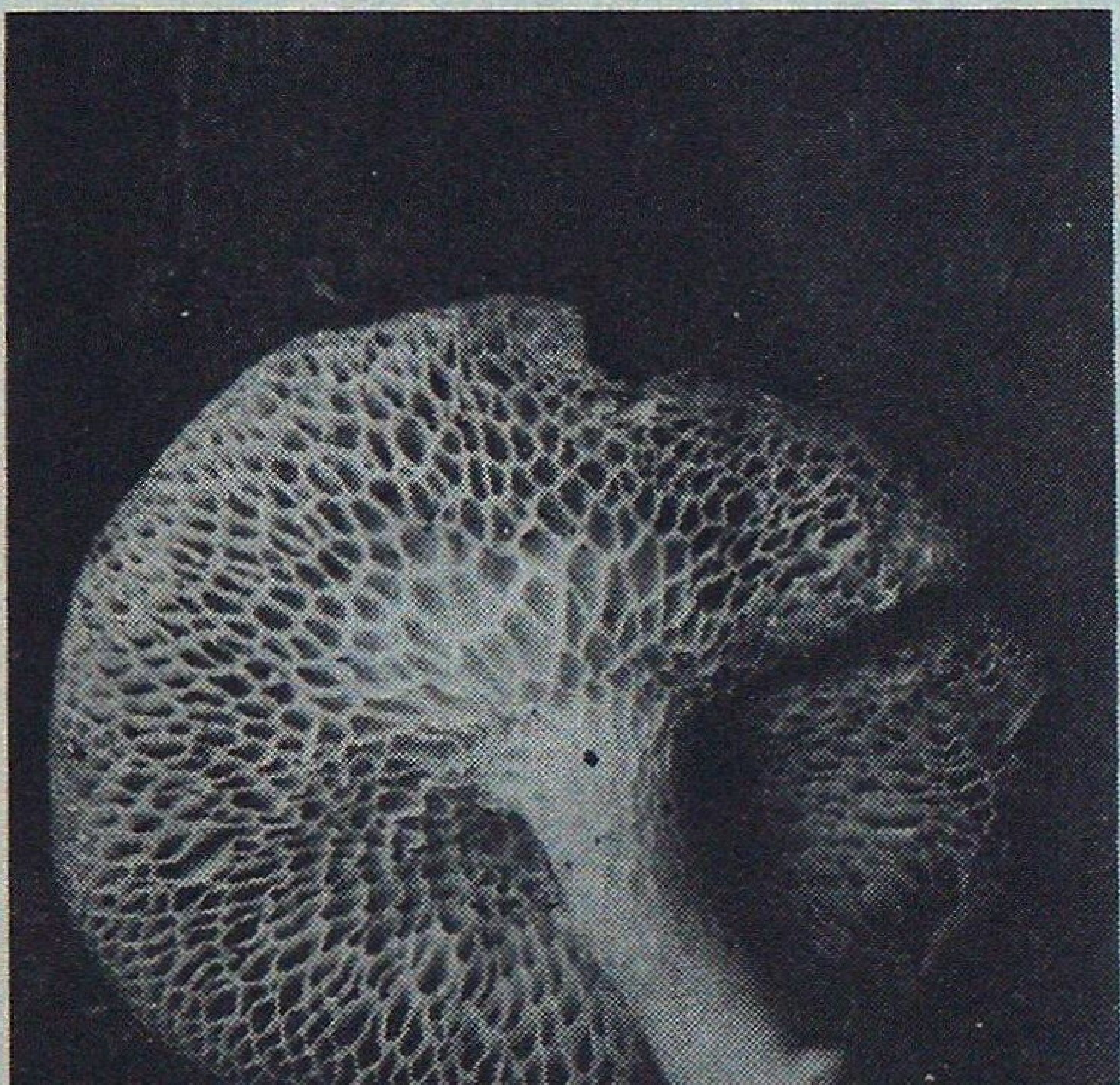
M.S. Rawat
and
V.K. Sharma

(V)

DIACHANTHODES NOVO-GUINEENSIS (HENN.) FIDALGO - A NEW RECORD FROM INDIA.

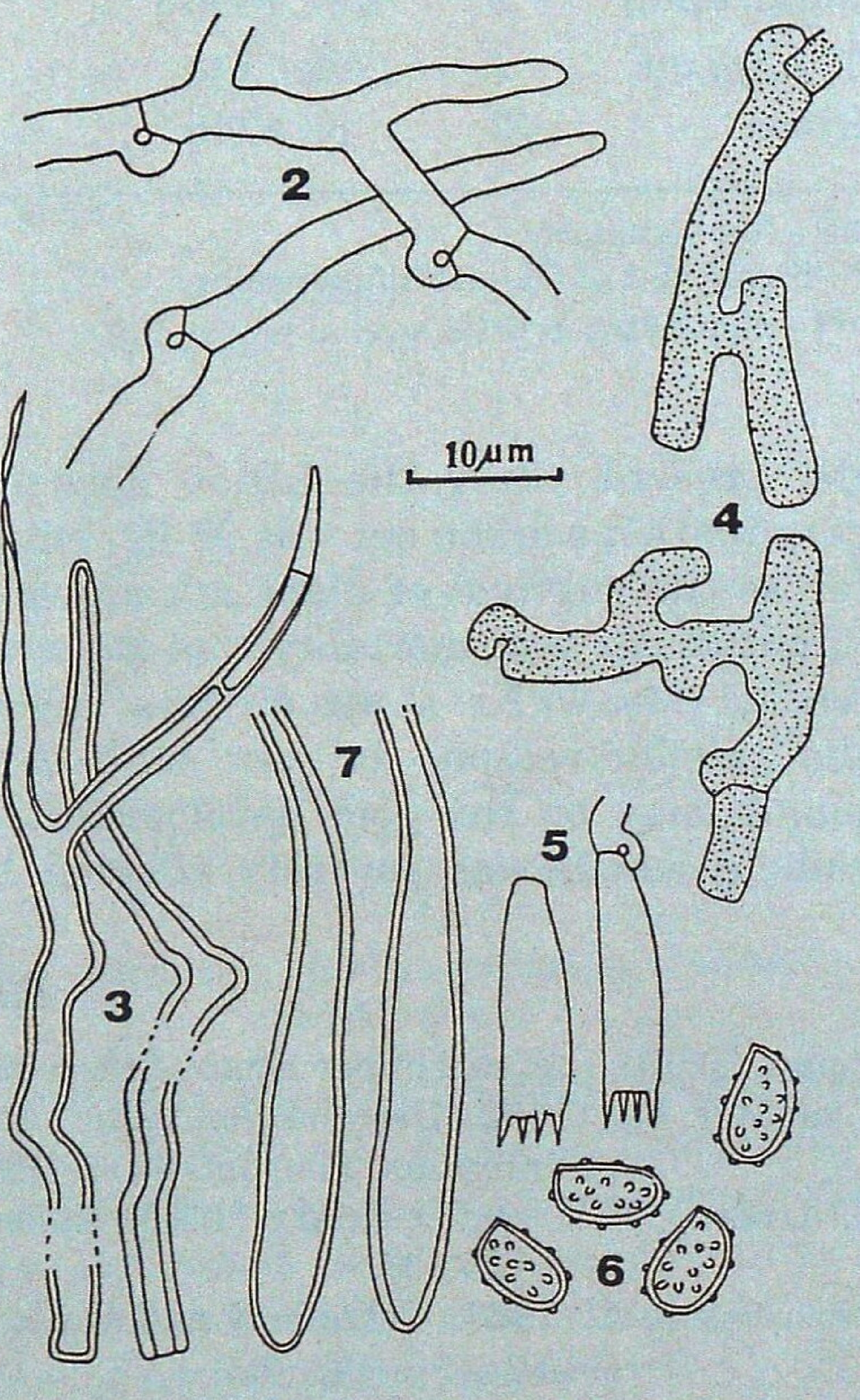
During a mycological excursion in October, 1990, a poroid fungus of Aphyllophorales was collected by author from Asansol, West Bengal, India. It was identified as *Diachanthodes novo-guineensis* (Henn.) Fidalgo. Perusal of literature (Bilgrami *et al.*, 1979, 1981; Butler and Bisby, 1960; Mukerji and Juneja, 1975; Rattan, 1977; Sarbhoy *et al.*, 1986; Tandon and Chandra, 1976; Tilak and Rao, 1968) revealed that this report constitutes its first record from India. Morphological and anatomical characters of the species based on this collection are given below.

Fig. 1



Basidiocarp of *Diachanthodes novo-guineensis* (Henn.) Fidalgo

Figs. 2-7



Microstructures of *Diachanthodes novo-guineensis* (Henn.) Fidalgo. 2. Generative hyphae, 3. Skeletal hyphae, 4. Conducting hyphae, 5. Basidia, 6. Basidiospores, 7. Cystidia.

Morphology : Basidiocarp (Fig. 1) annual, stipitate; stipe central, solid, cylindrical, stout, upto 5 mm thick, bearing pores upto the base; pileus circular with a slight central depression, 3 cm in diameter, 3 mm thick, margin thin, upper surface whitish, context white, 1.5 mm thick, soft, hymenial surface white, porous, pores angular, 1-2 per mm, pore tubes white, 1.5 mm thick.

Anatomy : Hyphal system dimitic. Generative hyphae (Fig. 2) nodose-septate, hyaline, thin-walled, 3-5 µm wide; skeletal hyphae (Fig. 3) hyaline, thick-walled, usually with wide lumina, rarely subsolid to solid, unbranched or biforked at the apical portion, 2.0 - 4.2 mm wide, apices of some skeletal hyphae are thin-walled and collapsed, sometimes bearing false septa at the distal end; conducting hyphae (Fig. 4) branched, thin-walled, 2.5 - 5.0 µm wide; basidia (Fig. 5) hyaline, thin-walled, clavate, 7.8 - 18.0 x 3.0 - 5.2 µm, tetrasterigmatic, sterigmata upto 2.8 µm long; basidiospores (Fig. 6) brownish, slightly thick-walled, ellipsoid, slightly apiculate, warty, dextrinoid, 6.5 - 7.8 x 4.0 - 5.2 µm; cystidia (Fig. 7) hyaline, thick-walled, cylindrical, 5.0 - 6.0 µm wide.

The voucher specimen has been deposited in the Mycological herbarium of Burdwan Raj College (BRCMH D-1), Burdwan, West Bengal, India.

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Burdwan (West Bengal)

A.B. De

From the Indian Forester - One Hundred Years Ago

THE INDIAN FORESTER

January, 1896 (pp 31-32)

SPINIFEX RESIN

Last year Sir William Macleay was kind enough to give me "a sample of gum used by the blacks for cementing the heads of spears and prepared from Spinifex roots," which had been collected by Mr. Walter Froggatt in the Napier Range (locally called Barrier Range), 100 miles inland from Derby, North-west Australia.

I was dubious as to it being the product of a "Spinifex" never having heard of a grass yielding a resin, but Mr. Froggatt is emphatic that he is not mistaken, nor is so experienced a collector likely to be. The Spinifex is probably *Triodia irritans*, R. Br., but further information on the subject, giving the mode of preparation of the resin would be very acceptable. Mr. Froggatt states that it is obtained from the roots, and local Europeans and aboriginals all make similar statements as to its origin.

It is in a cake about 4 inches in diameter, and 1¼ inch in thickness. The smell is something like beeswax, but at the sametime it has an exceedingly disagreeable and persistent odour which is not easily described. It reminds one of the smell of the fabric known as corduroy. It is of especial interest because it is of aboriginal preparation. Its colour is that of a dirty dark bronze-green, or almost of a slaty colour with a little green in it. To the naked eye it looks very like finely chopped hay of grass-seed cemented into compact mass. It is exceedingly tough, a sharp blow with a hammer on a cold chisel being necessary to fracture it.

Petroleum spirit extracts 3-2 per cent of a transparent, colourless fixed oil of fat, which possesses a little of the disagreeable odour of the original substance. The solvent extracts no resin. As the substance has been made up into cakes by the blacks, and is to that extent not an absolutely natural product, it may be that the fat, or a portion of it, has been introduced.

The substance was then digested in alcohol, which extracts a transparent, hard, golden-yellow resin possessing some odour, and which appears to be an interesting substance. The amount of this resin is 67.3 per cent, and it darkens on keeping. Water digested on the residue dissolves out 6.9 per cent, of colouring matter and salts. It contains no arabin. The remainder 23.1 per cent, consists of dirt and particles of chopped grass. This also is quite free from gummmattery.

Summary :- Fat, soluble in petroleum - 3.1, Resin, soluble in alcohol - 67.3, Extractive and salts, soluble in water - 6.9, Accidental impurity - 23.1

A second sample, treated with alcohol direct, yielded 70.8 per cent., to that solvent - (J.H. Maiden, in *Pro., Linn. Soc. N.S. W.* 1889)

OBITUARIES

The *Indian Forester* mourns the passing away of the following illustrious foresters :

1. Shri S.K. Srivastava,
   Madhya Pradesh Cadre,
   1958-61 batch IFC,
   Retired as CCF on June, 1994
   Expired on 10.10.95 due to cancer.

2. Shri P.B. Kamath,
   Madhya Pradesh Cadre
   1959-62 batch IFC,
   Retired as Addl. PCCF in October 1994
   Expired on 5.10.94 due to heart attack.

3. Shri N. Panchapakeshan,
   Maharashtra Cadre
   1951-53 batch IFC,
   Retired as Conservator of Forests,
   Expired in Nagpur.

4. Shri M. Ahmedullah,
   Orissa Cadre,
   1947 batch IFC,
   Retired as Conservator of Forests,
   Expired in September, 1994 in Vijianagaram.

May their souls rest in peace.

- Editor

GAZETTE NOTIFICATIONS

ANDHRA PRADESH GAZETTE

Shri P.V. Padmanabham, I.F.S., Divisional Forest Officer, Chittoor West Division is transferred and his services are placed at the disposal of Tirumala Tirupathi Devasthanams, Tirupathi for appointment on deputation as Dy. Conservator of Forests, Tirumala Tirupathi Devasthanams.

Shri P. Madhusudhana Rao, I.F.S. (82), Asstt. Chief Conservator of Forests (Estt.) O/o the Prl. Chief Conservator of Forests, Hyderabad is transferred and posted as Director, Shore Area Develpoment Authority in Environment, Forests, Science and Technology Department.

The services of Smt. R. Sobha, I.F.S. (86), Project Director, Distt. Rural Development Agency, Ananthapur are withdrawn from the Panchayat Raj, Rural Development and Relief Department and she is posted as Joint Secretary to Government, Finance and Planning (Plg. Wing) Department.

Shri Tej Singh Kardam, I.F.S. (1985), Dy. Conservator of Forests (Telugu Ganga Project) O/o the Prl. Chief Conservator of Forests, Hyderabad is transferred and posted as Joint Secretary to Government, Irrigation and Command Area Development Department.

KARNATAKA GAZETTE

On completion of Job training, Shri H.S.S. Murthy, IFS probationer of 1992 batch alloted to the Karnataka Cadre of IFS is appointed with immediate effect and until further orders as Assistant Conservator of Forests, Gundlupet Sub-Division, Gundlupet in the existing vacancy.

Shri Shiv Raj Singh, IFS (KTK 86), Deputy Conservator of Forests, on return from training abroad is appointed with immediate effect and until further orders as Deputy Conservator of Forests, Social Forestry and Training, Thattihalla, in the existing vacancy.

TRIPURA GAZETTE

The Governer is pleased to place the services of Shri V.K. Bahuguna IFS (MT-79), Conservator of Forests, Northern Circle, Kumarghat at the disposal of I.C.F.R.E., Dehra Dun for appointment on deputation as Asstt. Director General in the pay scale of Rs 4500-5700/- plus special pay of Rs. 500/- p.m. for a period of 5 (five) years with effect from the date he hands over the charge of the post.

WEST BENGAL GAZETTE

Shri T.B. Pundarikakashudu, I.F.S. has assumed the charge of the Chief Conservator of Forests, Soil Conservation and Eco-Develpoment, West Bengal in the forenoon of 25th September 1995.

Shri S. Palit, I.F.S. has assumed the charge of the Chief Conservator of Forests, Research and Development, West Bengal, in the afternoon of 13th Oct. 1995.

Shri P.K. Das, I.F.S. has assumed the charge of the Chief Conservator of Forests, Planning and Monitoring, West Bengal in the forenoon of 21st September, 1995.

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25-29 March 1996
Symposium on Remote Sensing of Environment. Vancouver, British Columbia, Canada.
Contact : Symposium on Remote Sensing of Environment, 13800 Commerce Parkway, Richmond B.C., Canada.

1-3 April 1996
Global Warming International Conference (GW7), Vienna, Austria, Global Warming International Center, P.O. Box 5275 Woodridge, IL 60517.

15-18 April 1996
SPOT - From a Decade of Accomplishment to a Decade of Promise.
La Villette, Cite des sciences et de l'industrie, Paris, France, SOCFI/SPOT, 14 rue Mandar, 75002 Paris, France.

29 April - 1 May 1996
Fourth Circumpolar Symposium on Remote Sensing of Arctic Environment. Copenhagen, Denmark.
Contact : Prof. P. Budmandsen. Fax : +45 45 993 1634.

21-23 May 1996
Second International Symposium on Spatial Accuracy Assessment in Natural Resources and Environmental Sciences. Colorado State University, Fort Collins, Colorade, U.S.A. Sponsored by IUFRO. Contact the Chair : H. Todd Mowrer, Spatial Accuracy Symposium, Rocky Mountain Forest and Range Experiment Station, 240 W. Prospect, Fort Collins, CO 80526-2098, U.S.A.

September 1996
Effects of Environmental Factors on Tree and Stand Growth. Dresden Germany.
Contact : Prof. Dr. Habil. G. Wenk, Technische Universitat Dreesden, Institut fur Waldwachstum und Forstliche Informatik, Wildsdruffer Strasse 18, 0-8223 Thrandt, Germany.

2-6 September 1996
World Heritage Tropical Forests Conference - Science for Better Management and Understanding. Cairns, Far North Queensland, Australia.
Contact : Conference Secretariat, P.O. Box. 1280, Milton, Queensland 4064 Australia.

7-11 October 1996
The Monte Verita Conference on Assessment of Biodiversity for Improved Forest Planning. Monte Verita, Ascona, Switzerland.
Contact : Dr. Michael Koehl, Swiss Federal Institute for Forest, Snow and Landscape Research (WSL/FNP) CH-8903 Birmensdorf, Switzerland.

26-28 October 1996
Resource Inventory Techniques to Support Agroforestry & Environment Activities.
Chandigarh, India.
Contact : Dr. Atul, Head Dept. of Agroforestry and Environment, H.P. Agriculture Univ., Palampur - 176 062, Distt. Kangra (H.P.), India.

4-7 November 1996
International Symposium on Assessment and Monitoring of Forests in Tropical Dry Regions with Special Reference to Gallery Forests. Brasillia, Brazil.
Contact : Prof. Dr Jose Imana Enclnas. Universidade de Brasilia, Departmento de Engenharia Florestal, 70.910-900 Brasilia DF, Brazil.

25-29 November 1996
International Conference on Tropical Forestry in the 21st Century. Kasetsart University, Bangkok, Thailand.
Contact : FORTROP'96 Secretariat, Faculty of Forestry, Kasetsart Univ., P.O. Box. 1054, Bangkok 10903, Thailand.

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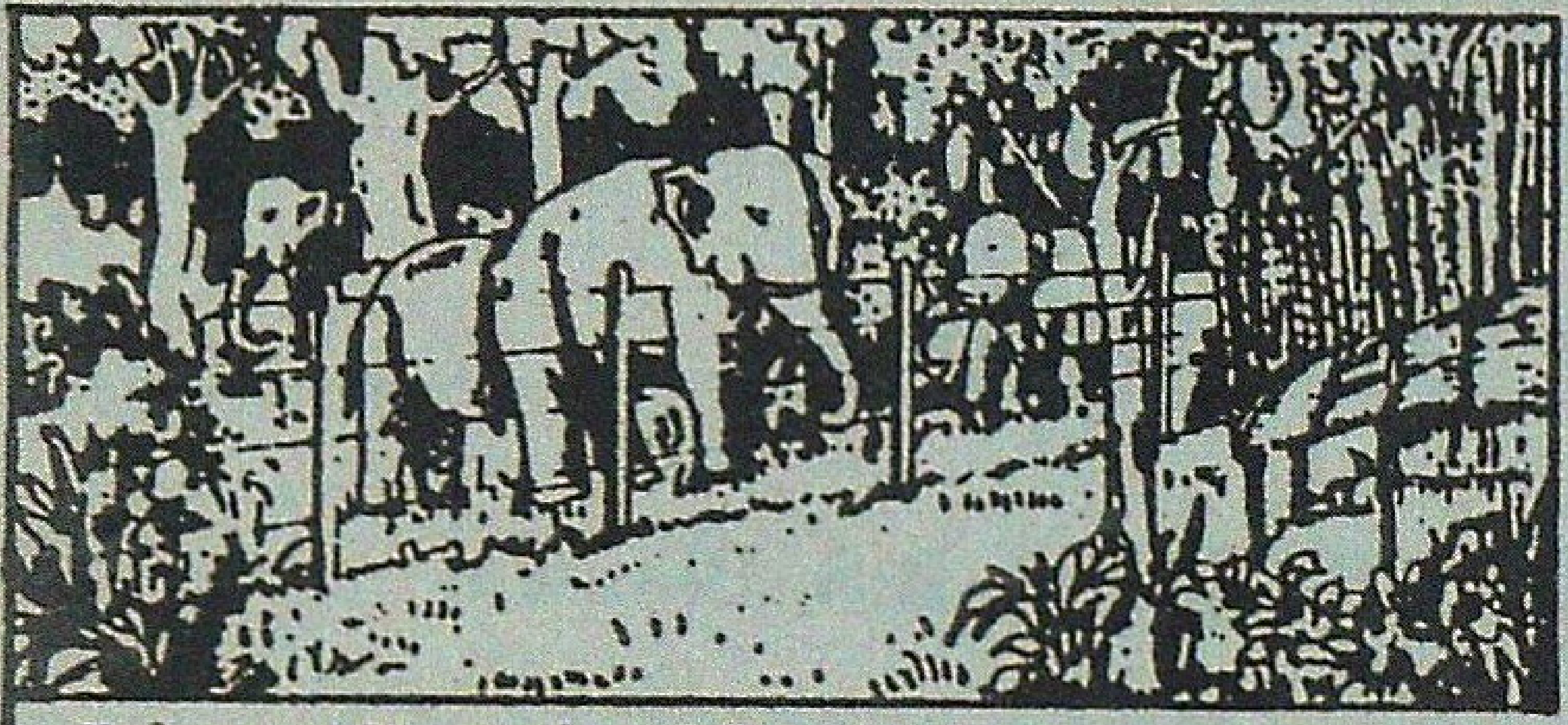

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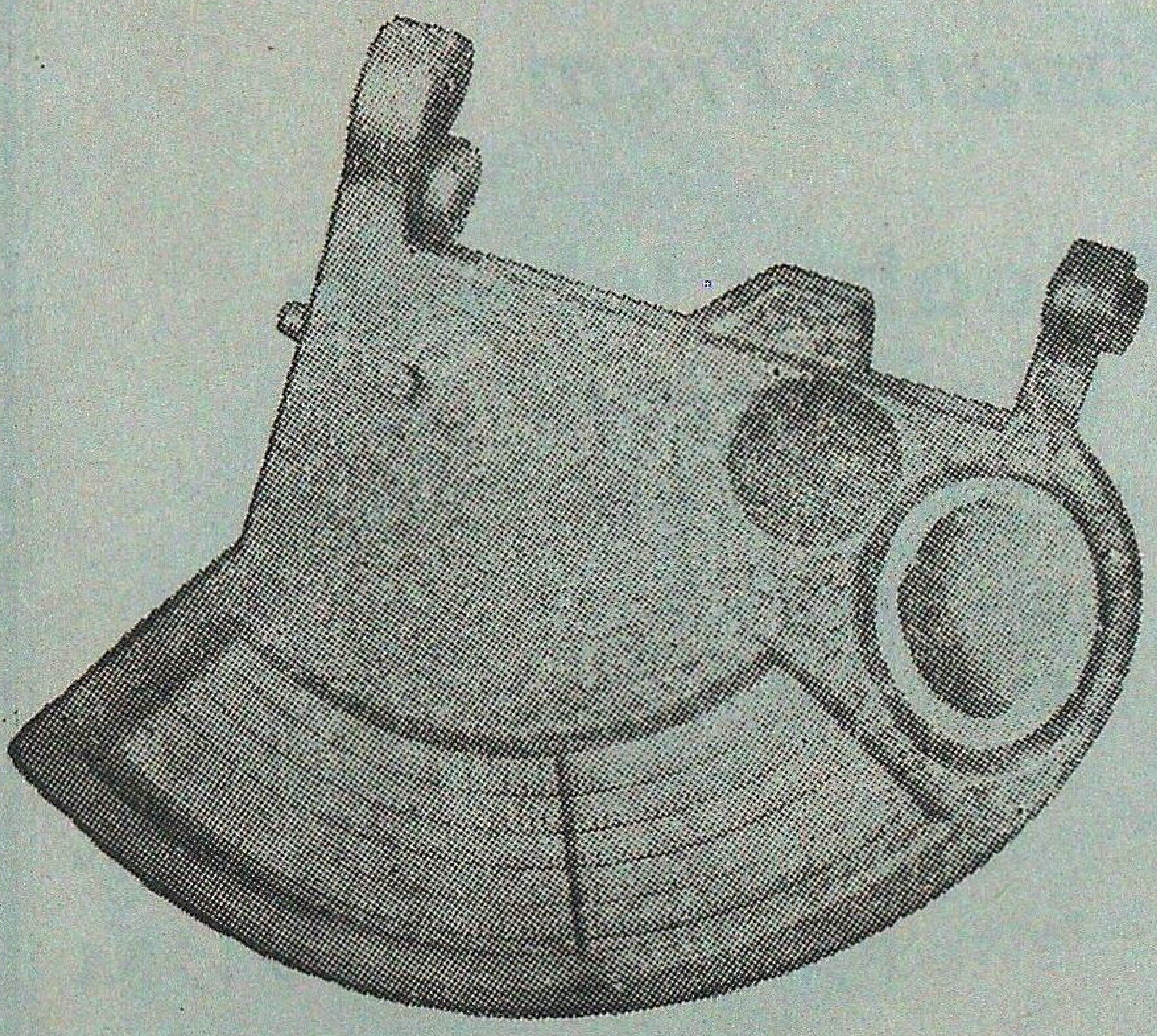

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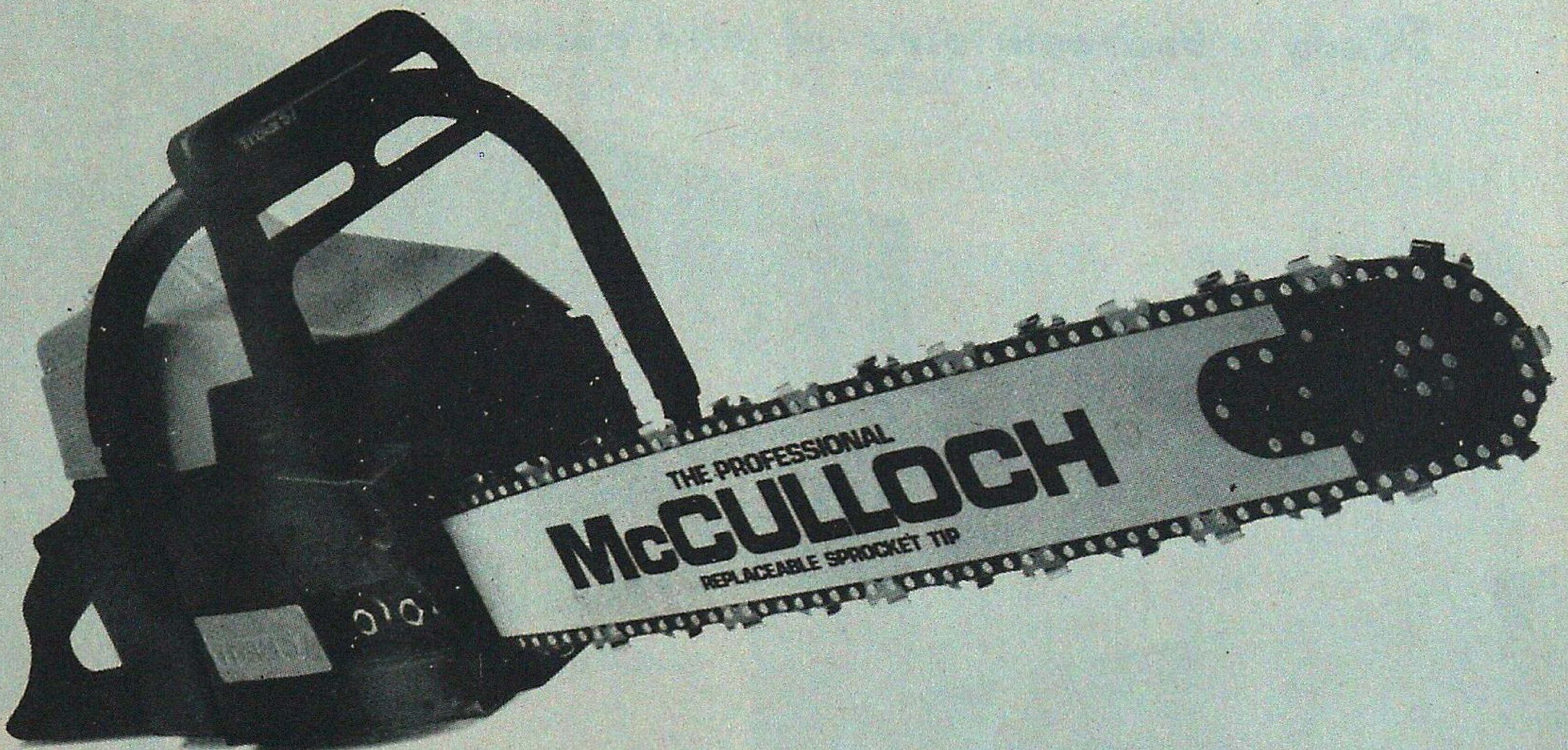

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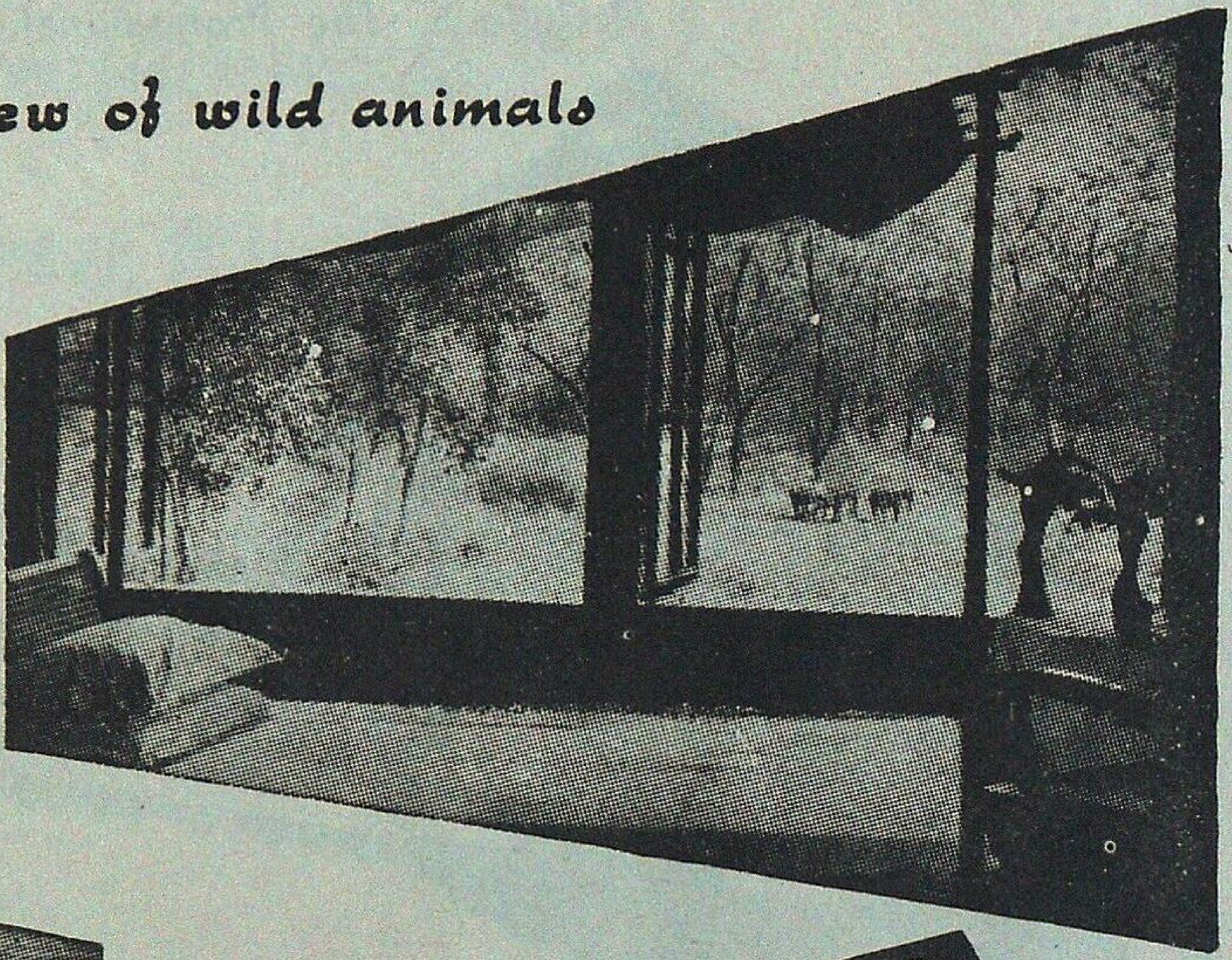

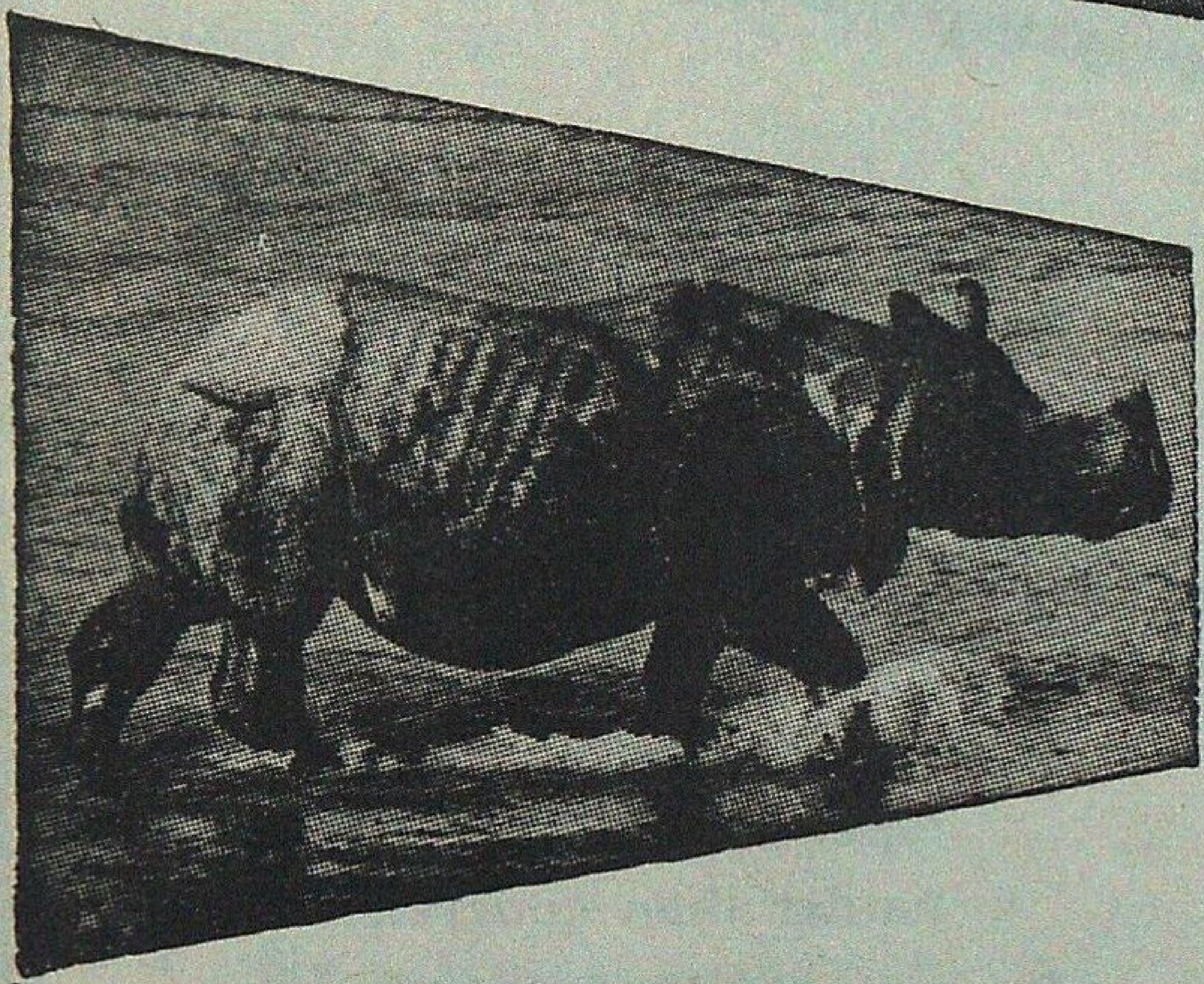

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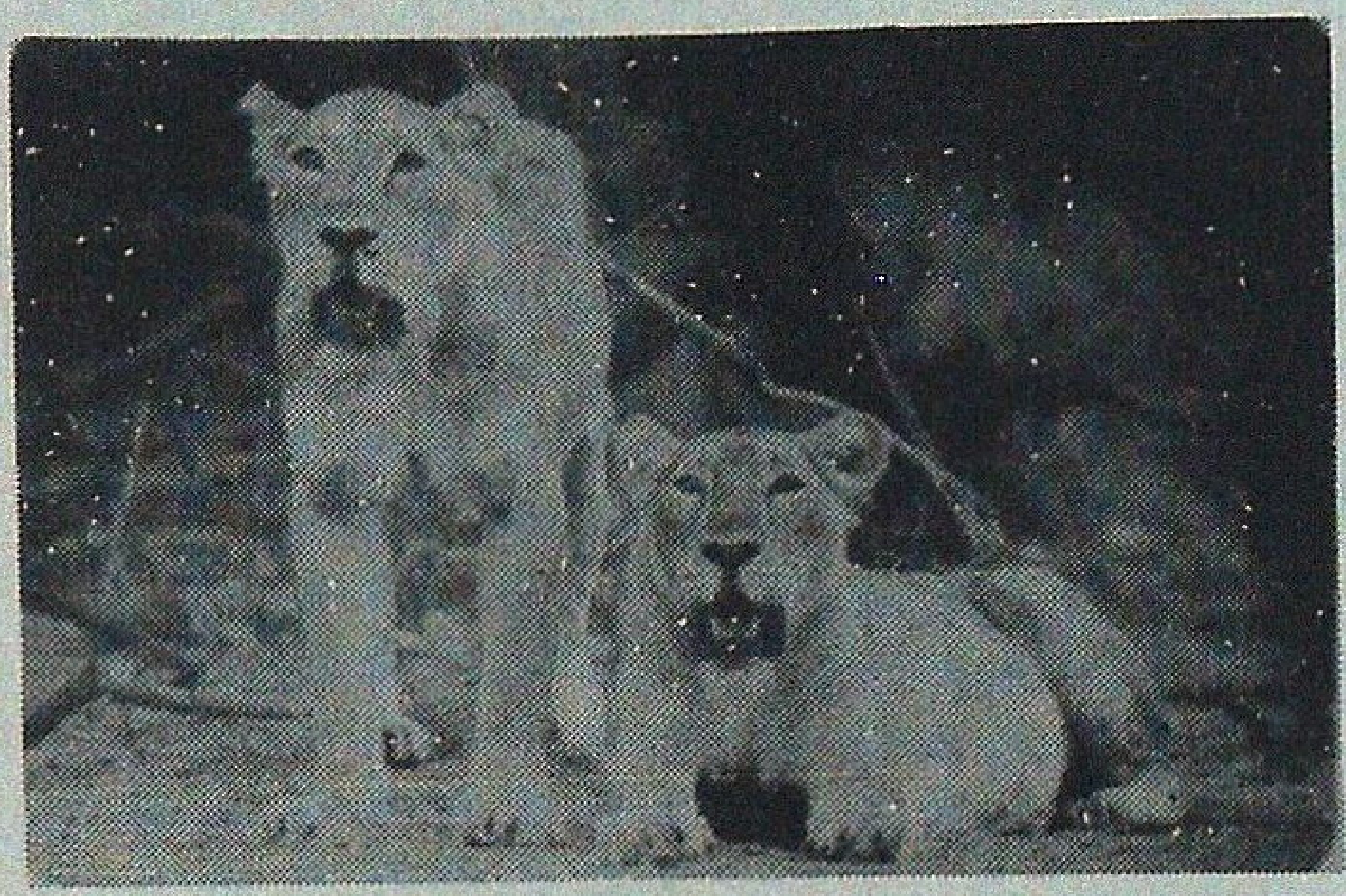

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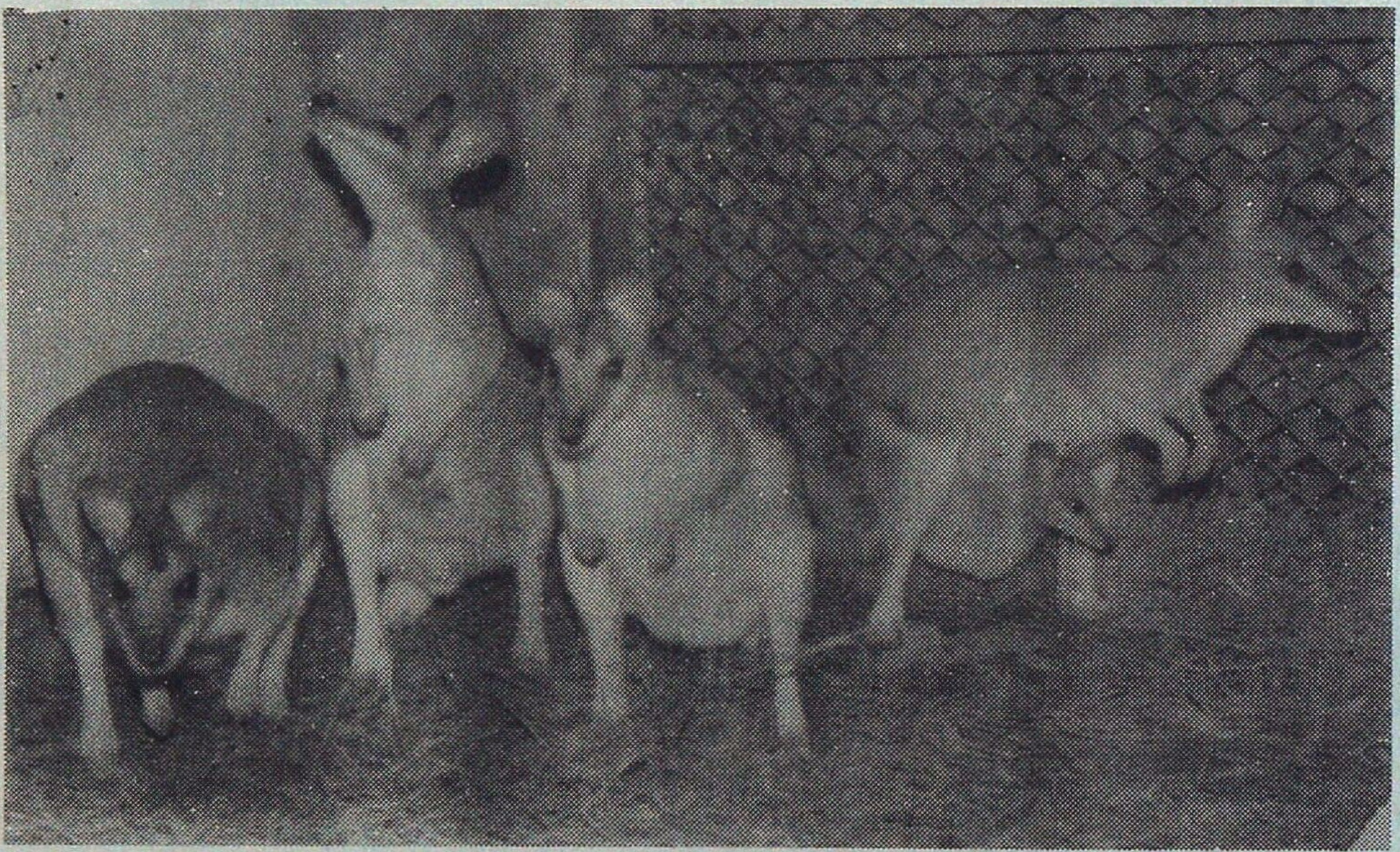

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Dy Conservator of Forests
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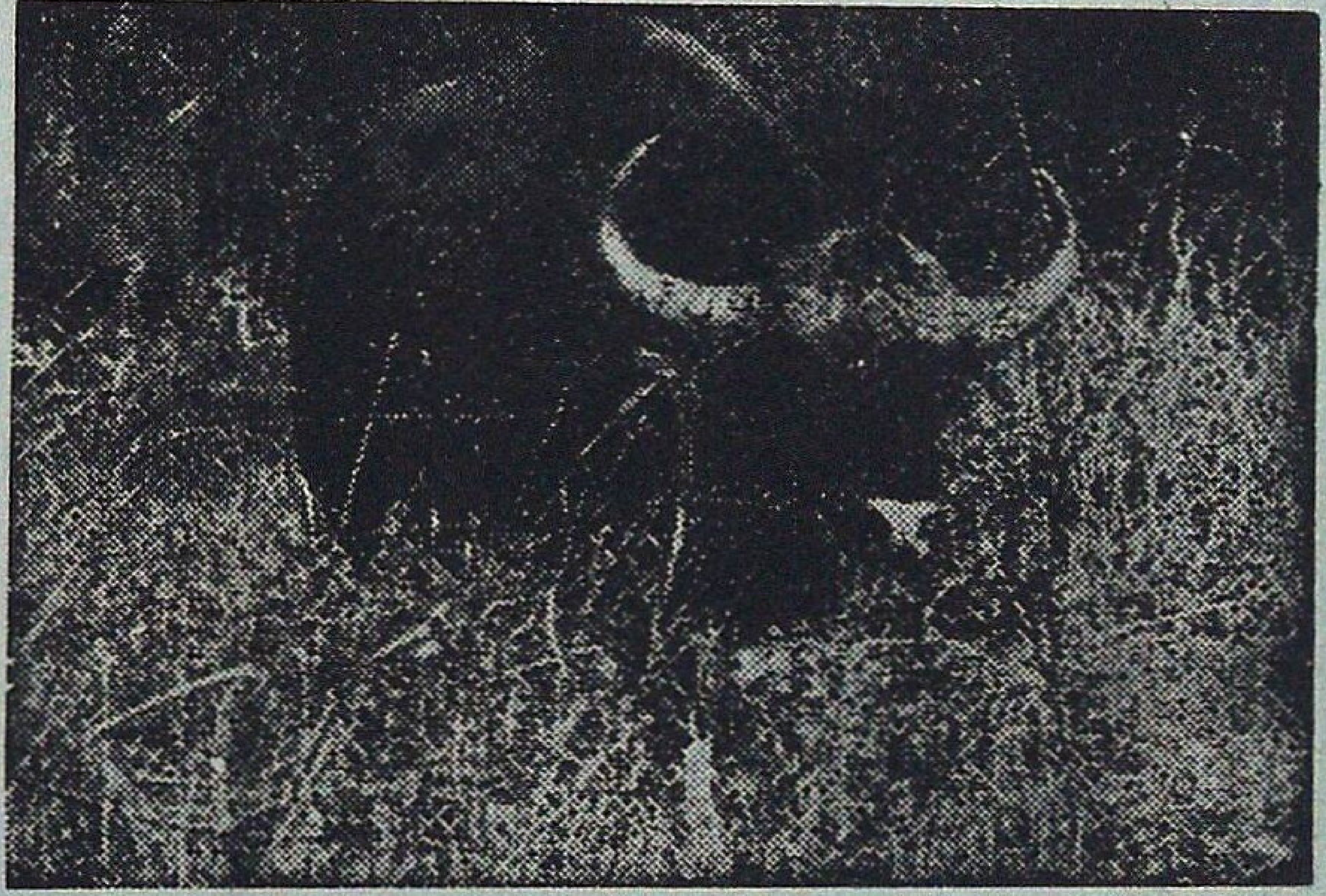


For further particulars write to :

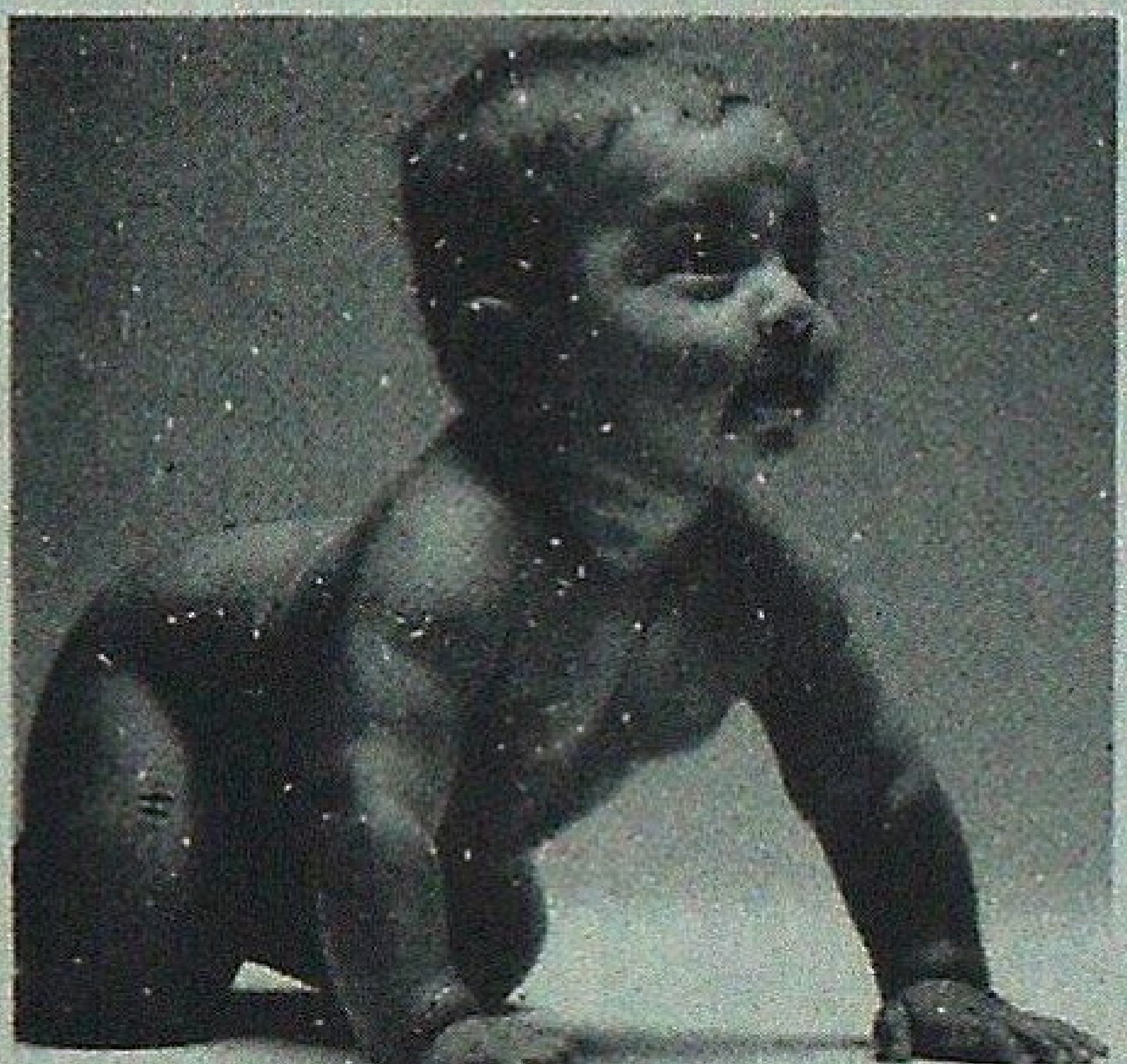
THE FIELD DIRECTOR,
PROJECT TIGER
Palamau Tiger Reserve.
P.O. Daltonganj, Bihar (India)

3 reasons STM is in the business it's in.

There are any number of reasons to be environment conscious but the three listed here should suffice.

Our forest resources are going up in smoke. Everywhere the cry goes up, Get rid of the woods. We need the wood'. You see, wood is the raw material for many processes and has numerous applications. And the logic being used is that in the interest of progress and commerce, if the forests have to be sacrificed, tough! The point is, it means progress in the short run and a dead planet in the long one.

Of course, we need wood. But maybe...just maybe, we don't need to sacrifice our forests to get it. The trick is in planting trees, lots of trees.



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But in today's dog-eat-dog, rat-eat-rat world, who's going to worry about the trees? The answer there is to offer people money to do so. Which is what we at STM have done. Get people to plant trees (or rather adopt them) for which they make money. And so do we, in the bargain!

Ah, did we hear the cynic say 'But you're going to chop down the trees anyway?' Yes, that's true, but since our plantations will provide the wood needed by the nation, there will be no need to level our forests. It's just like farming.

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2. Pithoragarh :	Milam Glacier	
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3. Almora :	Pindari Glacier	
	Loharkhet-Khati-Pindari Glacier	50 km

BEST VISITING TIME : 15TH JUNE - 15TH OCTOBER

For More Information Contact

Dy. Conservator of Forests
Nanda Devi National Park,
Joshimath (Chamoli)
Phone No. 2179

Director,
Nanda Devi Biosphere Reserve,
Gopeshwar (Chamoli)
Phone No. 2497

BANDIPUR NATIONAL PARK (Karnataka)

A Unit of Project Tiger

Best Season for visit : May to October but open all the year except in fire season from February to April.

Bandipur nestling itself at the foothills of the Western Ghats in Mysore District is a treasure trove of Wildlife, and a paradise for photographers. It encompasses an area of 880 sq. km.

- It harbours rich heritage of deciduous forests and variety of flora and fauna. Famous for sighting of elephants, gaur, sambar, chital, wild dogs, wild boar, sloth bear, common langur, barking deer and peafowl and if one is lucky, tiger and panther.
- Beautiful landscape and more than 180 spp. of beautiful birds to watch and enjoy.
- Approach :- Situated midway at 80 kms from both Mysore and Ooty.
- Nearest Airports :- Bangalore and Coimbatore.
- Nearest Railway Station :- Mysore and Ooty.
- Facilities :- Well furnished cottages with catering arrangement on order, conducted safari trips in vans abd joy ride on elephants.
- Safari timing- 0600 to 0900 hrs and 1600 to 1830 hrs.

For more particulars please contact :

Chief Wildlife Warden,
Aranya Bhavan,
Malleswaram,
18th Cross,
Bangalore - 560 003 (India)
Ph : 3341993

Field Director, Project Tiger,
and Conservator of Forests,
Wildlife South Circle,
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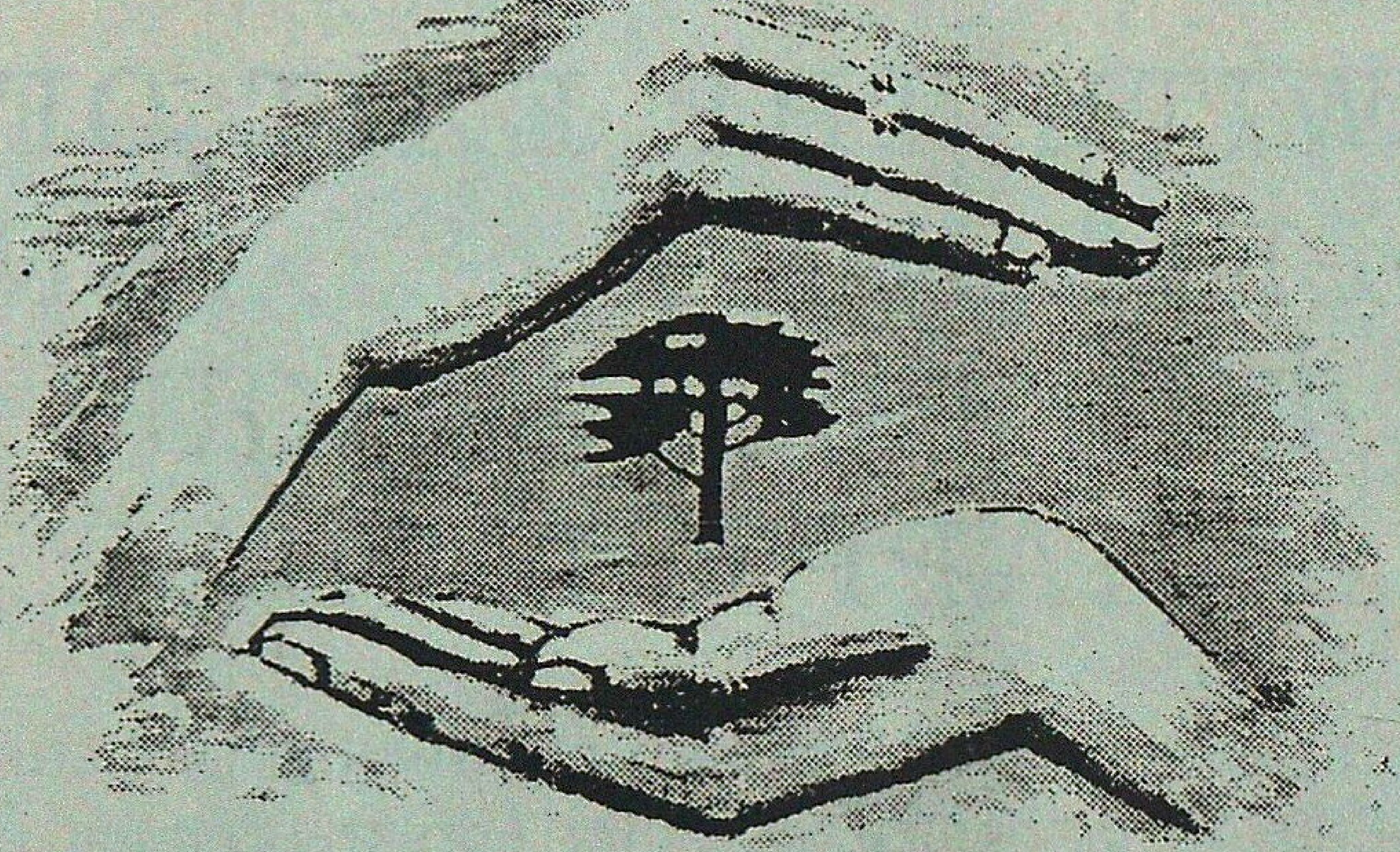

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Are you the sort of person who kills the goose that lays golden eggs? Unfortunately, certain elements of our own society have been ruthlessly cutting down our best friends-the trees, thus endangering themselves as well as the entire mankind. Trees play an invaluable role in maintaining the ecological balance and climate, stabilizing soil and water resources and safe guarding biological diversity.

It is precisely for such purposes that we setup TIMBERWORLD RESORTS & PLANTATIONS. Our singular global commitment is to create more environmental awareness and create an indelible impression for our cause by massive afforestation. In fact our plan envisages planting of 5 million trees over the next few years.

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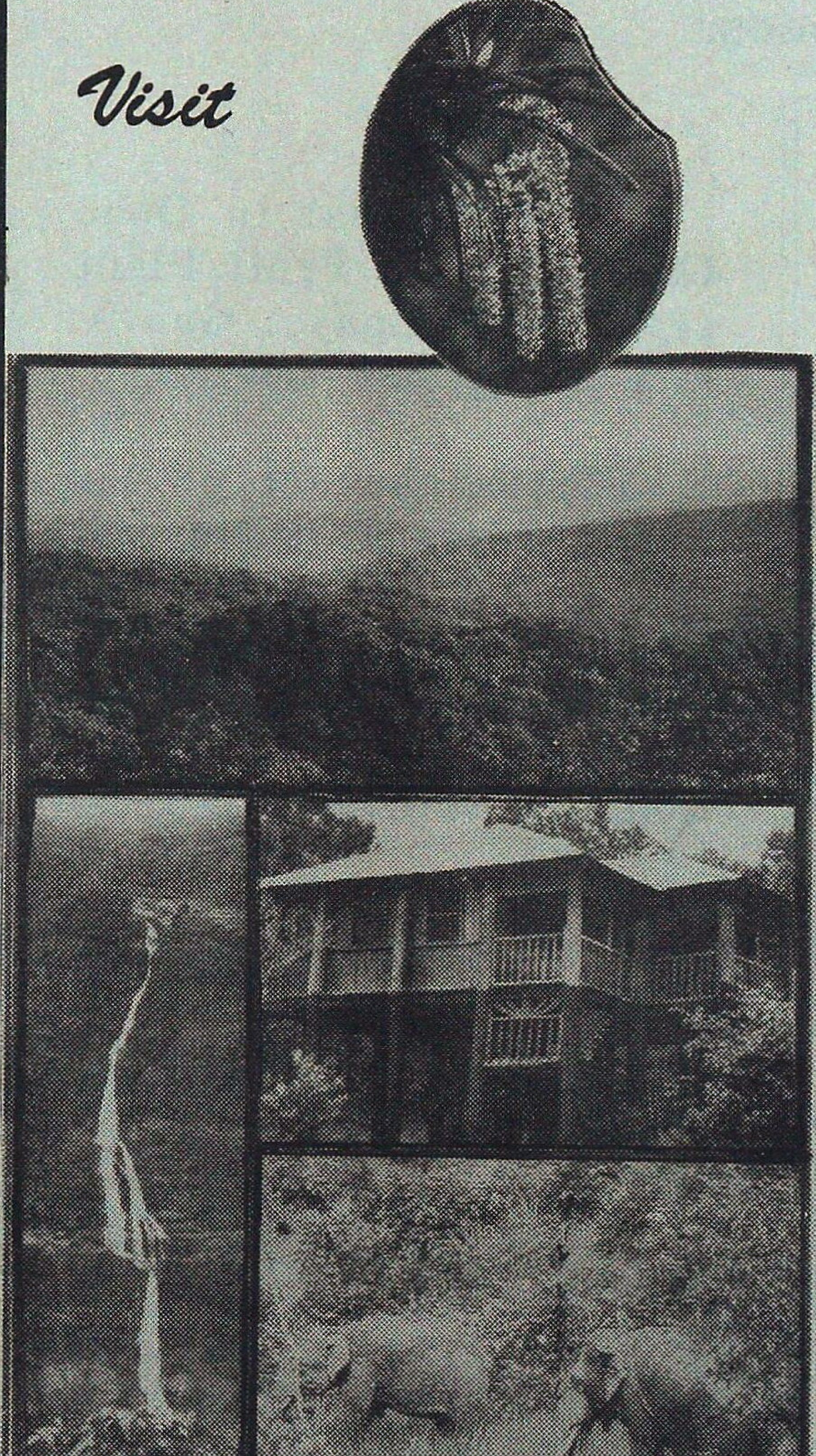

Best Known for :

- sal dominant semi-evergreen forest, orchids and faunal link betwen north and south.
- largest population of central Indian Elephants.

Visit season :
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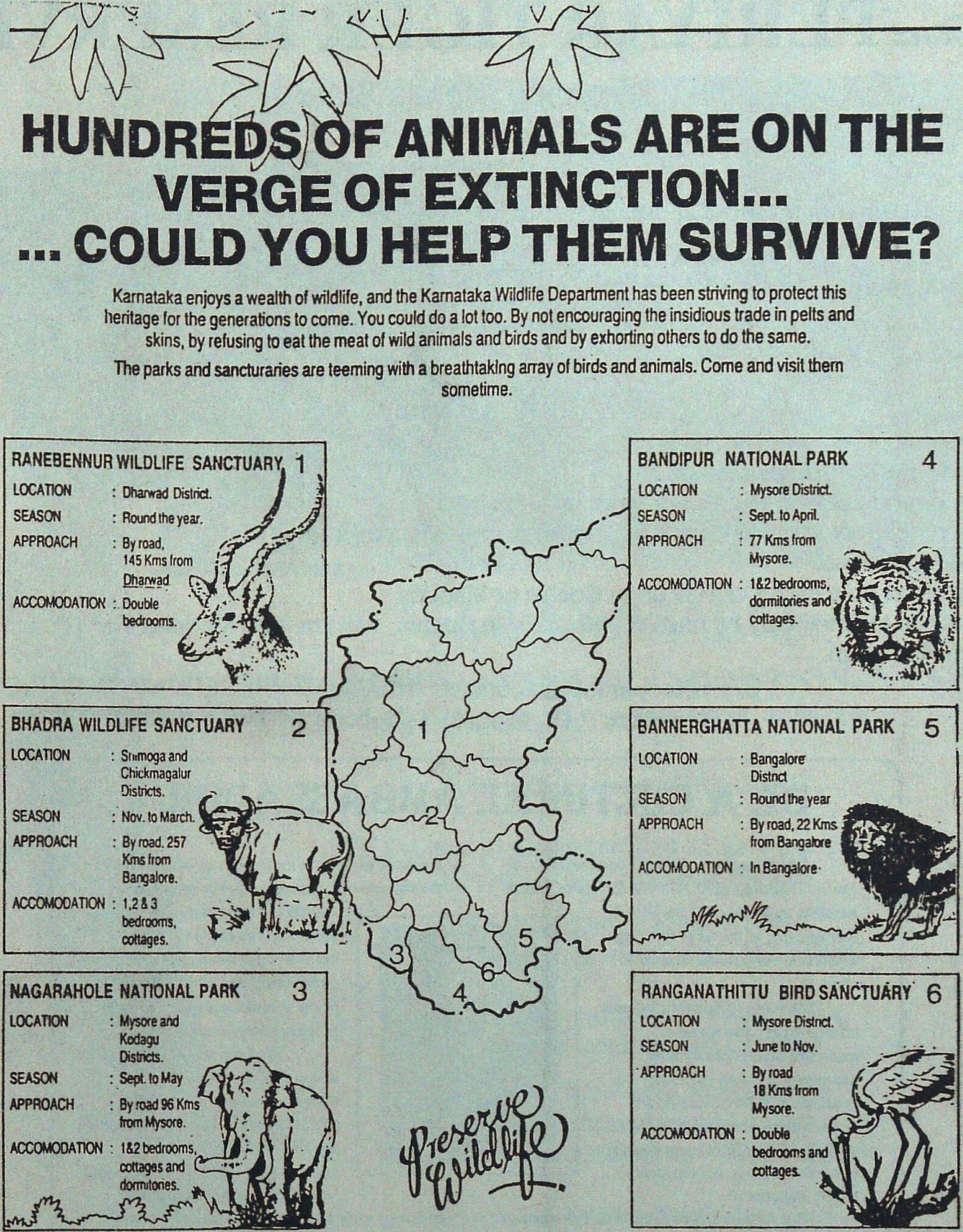

HUNDREDS OF ANIMALS ARE ON THE VERGE OF EXTINCTION... ... COULD YOU HELP THEM SURVIVE?

Karnataka enjoys a wealth of wildlife, and the Karnataka Wildlife Department has been striving to protect this heritage for the generations to come. You could do a lot too. By not encouraging the insidious trade in pelts and skins, by refusing to eat the meat of wild animals and birds and by exhorting others to do the same.

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SEASON : Round the year.
APPROACH : By road, 145 Kms from Dharwad
ACCOMODATION : Double bedrooms.

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NAGARAHOLE NATIONAL PARK 3

LOCATION : Mysore and Kodagu Districts.
SEASON : Sept. to May
APPROACH : By road 96 Kms from Mysore.
ACCOMODATION : 1&2 bedrooms, cottages and dormitories.

BANDIPUR NATIONAL PARK 4

LOCATION : Mysore District.
SEASON : Sept. to April.
APPROACH : 77 Kms from Mysore.
ACCOMODATION : 1&2 bedrooms, dormitories and cottages.

BANNERGHATTA NATIONAL PARK 5

LOCATION : Bangalore District
SEASON : Round the year
APPROACH : By road, 22 Kms. from Bangalore
ACCOMODATION : In Bangalore

RANGANATHITTU BIRD SANCTUARY 6

LOCATION : Mysore District.
SEASON : June to Nov.
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KARNATAKA FOREST DEPARTMENT (Wildlife Wing)
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MEGHA ADS

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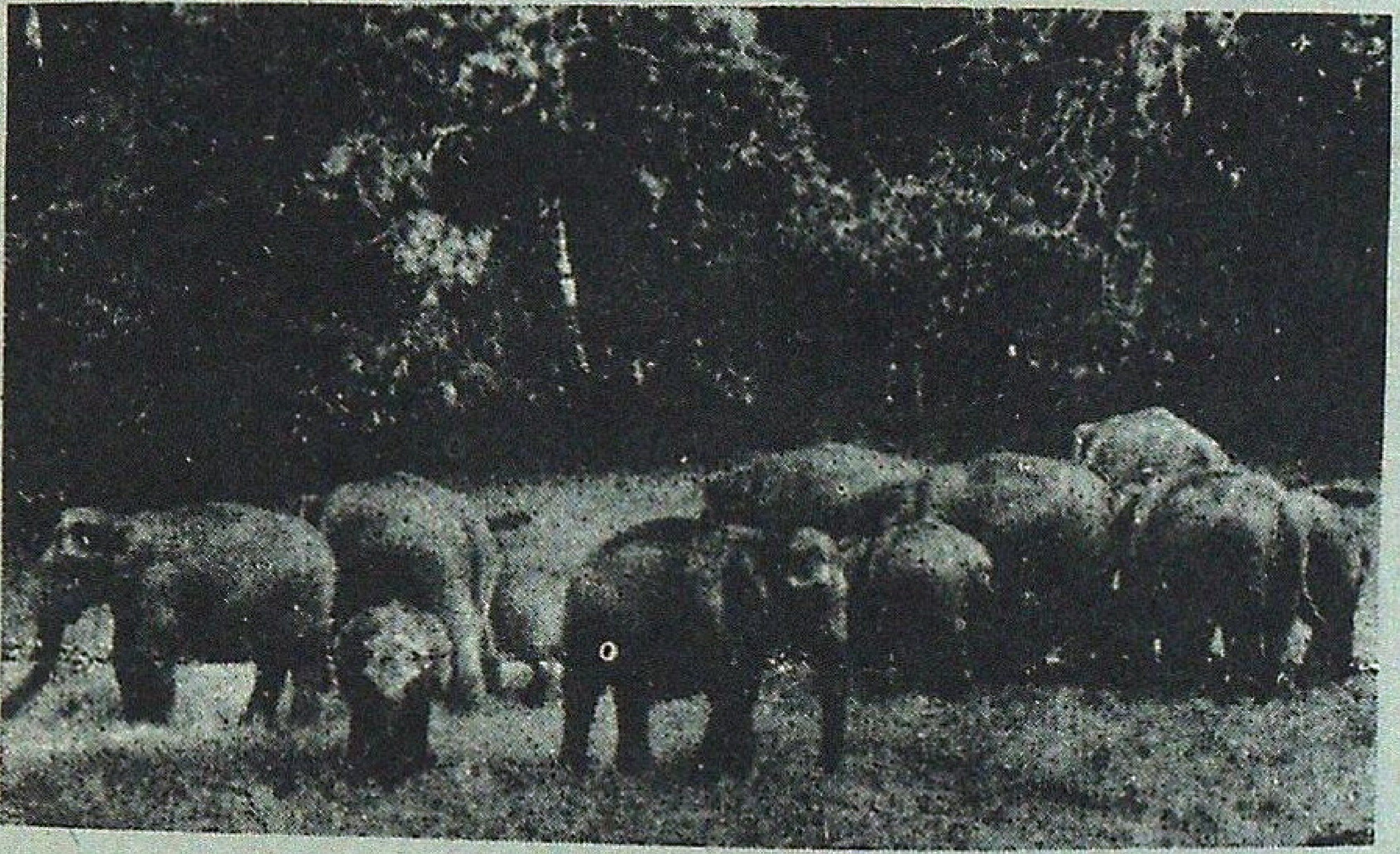

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For further particulars contact : WILD LIFE PRESERVATION OFFICER
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THE INDIAN FORESTER

VOLUME 122 JANUARY 1996 NO. 1

Forest resources being renewable, can sustainably be managed in a manner that is compatible with environmental conservation.

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